Vol. XXIV, No. 5 PSYCHOLOGICAL REVIEW PUBLICATIONS September, 1917

Psychological Review

CONTENTS

PUBLISHED BI-MONTHLY BY
PSYCHOLOGICAL REVIEW COMPANY
41 NORTH QUEEN ST., LANCASTER, PA.
AND PRINCETON, N. J.

Entered as second-class matter July 13, 1897, at the post-office at Lancaster, Pa., under Act of Congress of March 3, 1879

Psychological Review Publications

EDITED BY

HOWARD C. WARREN, PRINCETON UNIVERSITY (*Review*)
JOHN B. WATSON, JOHNS HOPKINS UNIVERSITY (*J. of Exp. Psych.*)
JAMES R. ANGELL, UNIVERSITY OF CHICAGO (*Monographs*)
SHEPHERD I. FRANZ, GOVT. HOSP. FOR INSANE (*Bulletin*)
MADISON BENTLEY, UNIVERSITY OF ILLINOIS (*Index*)

WITH THE CO-OPERATION OF
MANY DISTINGUISHED PSYCHOLOGISTS

PSYCHOLOGICAL REVIEW

containing original contributions only, appears bimonthly, January, March, May, July, September, and November, the six numbers comprising a volume of about 480 pages.

PSYCHOLOGICAL BULLETIN

containing critical reviews, notices of books and articles, psychological news and notes, university notices, and announcements, appears monthly, the annual volume comprising about 480 pages. Special issues of the BULLETIN consist of general reviews of recent work in some department of psychology.

JOURNAL OF EXPERIMENTAL PSYCHOLOGY

containing original contributions of an experimental character, appears bimonthly, February, April, June, August, October, and December, the six numbers comprising a volume of about 480 pages.

PSYCHOLOGICAL INDEX

is a compendious bibliography of books, monographs, and articles upon psychological and cognate topics that have appeared during the year. The INDEX is issued annually in May, and may be subscribed for in connection with the periodicals above, or purchased separately.

ANNUAL SUBSCRIPTION RATES

Review and Bulletin: $6 (Foreign, $6.50). **Journal:** $3.25 (Foreign, $3.50).
Review and Journal: $6 (Foreign, $6.50). **Bulletin:** $3.25 (Foreign, $3.50).
Journal and Bulletin: $6 (Foreign, $6.50).
Review, Bulletin and Journal: $9 (Foreign, $9.75).
Index with any other two: $7 (Foreign, $7.50).
Review, Bulletin, Journal and Index: $10 (Foreign, $10.75).
Current Numbers: Review, 65c; **Bulletin,** 35c; **Journal,** 65c; **Index,** $1.25.

PSYCHOLOGICAL MONOGRAPHS

consist of longer researches or treatises or collections of laboratory studies which it is important to publish promptly and as units. The price of single numbers varies according to their size. The MONOGRAPHS appear at irregular intervals and are gathered into volumes of about 500 pages with a uniform subscription price of $4.. (Postal Union $4.30.)

Philosophical Monographs: a series of treatises more philosophical in character.
Library of Genetic Science and Philosophy: a series of bound volumes.

Subscriptions, orders, and business communications may be sent direct to the

PSYCHOLOGICAL REVIEW COMPANY
Princeton, New Jersey

FOREIGN AGENTS: G. E. STECHERT & CO., London (2 Star Yard, Cary St., W. C.); Leipsig (Koenigstr., 37); Paris (76, rue de Condé)

VOL. XXIV. No. 5 September, 1917

THE PSYCHOLOGICAL REVIEW

AN ATTEMPTED FORMULATION OF THE SCOPE OF BEHAVIOR PSYCHOLOGY[1]

BY JOHN B. WATSON

The Johns Hopkins University

COMMON SENSE PROCEDURE

Psychology a Science of Behavior.—Psychology is a division of science which deals with the functions underlying human activity and conduct. It attempts to formulate through systematic observation and experimentation a series of principles or laws which will enable it to tell with some degree of accuracy how an individual or group of individuals will adjust themselves to the daily situations of life as well as to the uncommon and unusual situations which may confront them. It is equally a part of the function of psychology to establish laws or *principles for the control of human action* so that it can aid organized society in its endeavors to prevent failures in such adjustments. It should be able to guide society as to the ways in which the environment may be modified to suit the group or individual's way of acting; or when the environment cannot be modified, to show how the individual may be moulded (forced to put on new habits) to fit the environment. It must be understood at the outset, though, that psychology at present has little to do with the setting of social standards of action and nothing to do with moral standards. It does lie within her province to tell

[1] The material presented in this article is essentially that which will be used in the first chapter of my forthcoming book, 'Human Psychology.' It is published now in the hope that helpful criticism will be furnished the writer both as regards the level of presentation, that is, its textual fitness, and as regards the completeness with which the scope, as here outlined, touches the main points of interest in modern psychology.

whether the individual can act in accordance with such standards and how we may control him or lead him to act in harmony with them. These laws of control or training must be general and comprehensive since social standards are constantly changing.[1]

Psychology when looked at in this way is seen to be something which everyone has been using more or less all his life without calling it psychology. We learn by failures and successes how to run our business, how to get along with our colleagues and associates. We teach our children to act in certain ways. They must eat with a fork, learn to dress themselves, to treat their playmates as they themselves like to be treated, to master the three R's, and then later a trade or profession. We skillfully or bunglingly steer them on their course from infancy until they no longer need our guidance.

The Ancient Origin of Psychology.—Indeed a glance at the mythology, folk-lore, or history of any given race will show that the practical psychology of control began as soon as there were two individuals on the earth living near enough together for the behavior of one to influence the behavior of the other. The serpent controlled Eve's behavior by offering her the delectable apple. Eve learned her lesson quickly and tempted Adam in the same way. Atalanta, the swiftest of runners, was beaten not through the superior agility of Hippomenes but by the fact that she could not resist the temptation to stop and pick up the golden apples thrown by her suitor. The taboo system, the initiation ceremonies and the machinations of the medicine men all serve to illustrate progress towards the control of group and individual behavior.

Common Sense Procedure in Securing the Control of Behavior.—Long before the dawn of modern scientific psychology society found that by roundabout, hit-and-miss methods she had secured a fairly serviceable body of data as to what man can do—his complement of acts; the appropriate situation for calling out any given act; and crude

[1] For a more scientifically worded discussion of the province of psychology see p. 336.

training methods whereby the repertoire of the acts themselves might be enlarged. A brief glance at the practical procedure in securing control of individuals and groups may serve to illustrate both how such data are obtained and how they are used.

The situations or devices for drawing crowds for whatever purpose show the greatest development of skill in practical psychology. If one or two individuals happen by chance to gather around a patent medicine vendor the vendor's momentary success is assured. The small crowd is an irresistible stimulus and soon gathers unto itself a larger crowd. For this reason initial buyers, listeners, applauders, and, yes, even sometimes suitors and mourners are provided and paid for before the public is allowed to act. The advertisement of a 'fire sale' is likewise an ancient and honorable device for gathering a crowd. The announcement at Jamestown of a shipload of virtuous women to be sold as wives apparently, if historical report can be trusted, brought out the whole of the unmarried able-bodied male population of Virginia.

After the crowd has collected devices for controlling the individual are numerous. Chief among these we find the various lottery schemes; many individuals will not give twenty-five cents for a charitable purpose, but at any charity gathering they will eagerly take one of a dozen twenty-five-cent chances on almost any object the total value of which need not be greater than the cost of a single chance. So uniform is the response to lottery schemes that they have oftentimes become national mediums for raising government funds.

Organized society displays much ingenuity in devising situations for the control of reaction: the clergymen, having found empty pews under an orthodox type of routine, and that the young people were not engaging in church activities, began to try out in a similar way what could be done by altering the old austere situation and by creating for the church entirely new situations. The exteriors of the churches were vastly modified, the interiors decorated, rest and play

rooms added as well as gymnasia and playgrounds. A certain type of action was expected and the church arranged a situation to bring it about. We see the same attempt at control illustrated in governing bodies: state legislatures, depressed by the prevalence of drunkenness and crime, establish a new situation by prohibiting the sale of drugs and spirituous liquors in the hope that legislation will prevent such conduct. Finally, mention may be made of recent changes in prison methods. The more advanced prisons, becoming dissatisfied with the amount of insubordination, vice, sloth, and ignorance of all forms of government among the inmates, are trying a new situation with good results, viz., that of letting the inmates establish a miniature republic. This republic makes its own laws and metes out its own punishments. Society has developed a *system of standards of action but it does not know just what situations will produce the needed responses.* The situations are set up in the social field by trial and error; they are modified, changed, etc., until the desired reactions take place, or until they are despaired of.

Watching the Act to Obtain Data on the Situation.—We thus, as we see, get a part of our knowledge of the factors underlying behavior by the trial and error method of manipulating the situation and noting the reactions that take place. This gives us a body of usable data on what to expect of men when they are placed in certain situations. We deal here with situations of our own contrivance. Equally serviceable results are obtained by taking an individual who is performing some act (action not regulated by the observer) and examining immediately into the situation which led to that act—the act is known, the situation which led to it must be investigated. This method is of course supplementary to the first. It extends our knowledge of situations and what to expect from them, and at the same time adds to our knowledge of man's repertoire of acts. Illustrations of the results of this type of practical procedure are numerous; it is hard to convince a mother that she cannot predict[1] what

[1] By prediction we mean nothing but the common-sense, scientific, and logical use of material gathered from observation and experimentation. The planet Neptune was predicted, Mendelian ratios are predictable, coat color or eye color of animals can, within certain limits, be predicted before the birth of the animal.

the situation is which leads her baby to give a certain cry. Depending upon the variations in the cry she will say that the 'baby is hungry, wet, or has colic' (her conclusions are often wrong, be it said). Advancing somewhat in the age scale we see, in passing through a forest, a youth trained to hunt firing upward into a tree, and we note that the dog he has with him has 'treed.' An observer responds to this picture by telling his companion that the boy is hunting *squirrels*. But if he sees the boy fire in another way, say horizontally, and sees a dog in the act of pointing, he will state that the lad is hunting *quail*. If the boy fires towards the ground and has a hound with him, he is shooting *rabbits*. Finally, if he is seen in the hunting fields on horseback, with no gun but accompanied by a pack of hounds, in full cry, our observer remarks that the boy is hunting a *fox*. Watching his actions and taking note of all attendant circumstances enables anyone to predict with some degree of probability the immediate situation leading to the boy's actions. Our ability to observe an act and predict the possible or probable stimulus to that act depends upon the fact that often during our past life, when we have seen individuals doing certain things, we have immediately investigated the situations which led to the acts.

Need of Acquaintanceship with an Individual's Past.— When we come to deal practically or scientifically with individuals too much emphasis cannot be laid upon the extent to which acquaintanceship with their past life will gradually afford the basis for making serviceable predictions as to their probable ways of acting and as to the situations which will call out any given act. This can possibly be most easily illustrated in the animal world. We soon come to the prediction stage with our horses and dogs and can map out with some certainty what they would do under the various situations which might confront them. After watching two monkeys for several years I found after repeated observation that *B* would not touch food until *J* had finished and left the dish, and that *J* would eat and stuff three bananas into his cheek pouches and drag off another with his right forefoot;

that *J* would attack a problem box rapidly and in a rough and harum scarum way—pulling the box towards him, turning it over and maltreating it generally; that *B* would approach cautiously, moving the parts slowly and with no violence; but as a rule would solve the problem before *J*.

But with an organism so highly developed as man's, the prediction of his actions is not always so easy. An individual's actions in everyday situations depend upon such complex factors as his heredity, his past success in adjustments and his failures of adjustment, the responses he has just had to make, as well as upon the permanent and temporary conditions of his organic mechanisms (digestion, circulation, sleep, etc.). A badly cooked dinner, an insufficient amount of food (as in the case of a person who is dieting), extreme heat, etc., may so change the state of the organism that the response reasonably expected is not forthcoming. A forthcoming marriage, graduation, separation, offer situations which, by their involvement of emotional factors, may almost completely disrupt for the time being the everyday systems of responses which are customary with a given individual. In such a complex setting a man may show a temporary breakdown; he may make blunders or show a general inability to go through with his ordinary routine. A bad dream or a slight rebuff at the hands of a friend likewise may upset a man's reactions for a whole day. Further on we shall see that many of the habits formed in childhood and in adolescence, now long since discarded, such, *e. g.*, as attachments to early playmates, to members of the family, early love affairs, may have had a prepotent influence in shaping the whole course of adult acquisitions.

If we are called upon to predict what a stranger of twenty-five years of age will do when confronted in a dark alley by a burglar, we are almost, but not quite, helpless so far as prediction is concerned. Now give us an opportunity of systematically studying the make-up of the man, of knowing something of his reactions in past dangerous situations, the stability of his emotional tendencies, and we shall be able at least to make a crude but serviceable prediction, viz.,

that he will quietly throw up his hands and let the burglar go through his pockets. He will neither become hysterical, attempt to attack the burglar, nor will he suffer any severe after-effects by reason of his experience. The chances are good that he will report his mishap to the police, confess to his wife or friends that he has been held up, and then will cease to be further troubled by the experience. In another type of individual, whose heredity is questionable, whose reactions are unstable, who is generally excitable and liable to over-reaction, we venture the prediction that even if he does throw up his hands (which he does not always do) and allow himself to be robbed, he will go to pieces after the experience and may suffer some serious and lasting consequences.

Common Sense a Crude but Genuine Psychology.—Most of our illustrations have involved little or no technical psychology and yet they do illustrate a genuine psychological procedure. The business man, the artist, and the artisan have built for themselves rather definite rules of psychological procedure without ever calling it psychology. The church and the theater illustrate this equally well. It is possibly even a debatable question whether common sense has not kept closer to the fundamental truth underlying the psychology of reaction than has the too detached psychology of the laboratory. But even those who are the best practical psychologists realize that common sense methods can never produce universal or widespread progress in psychology. Our great military leaders, our great religious leaders, the demagogues and the politicians have accomplished their results by their very wide acquaintanceship with the reaction tendencies in man and by their happy accidents in creating the situations which will call out such reactions. By reason of the fact that occasional success has been obtained by crude methods and happy accidents, we must not conclude that psychology should not attempt to discover and analyze and bring under scientific control the factors which have occasionally made such successes possible. Because there has been an occasional business leader who knew how to

pick out and keep good men, we are offered no reason why we should not seek to understand and control the processes involved in picking and keeping good men. The same may be said of the factors involved in keeping men out of crime, keeping them honest and sane, and their ethical and social life upon a high and well-regulated plane.

This brief summary of the everyday uses of psychology should convince us of two things; first, that common sense, while a reasonable method so far as it goes, does not go far enough and never can; and secondly, that in order to make progress, the phenomena of human behavior must be made an object of scientific study. We shall attempt next, then, to gain some impression of this systematic psychological procedure.

Scientific Procedure

The Detailed Subject Matter of Scientific Psychology.—As a science psychology puts before herself the task of unravelling the complex factors involved in the development and regulation of human behavior from infancy through old age. At first sight it may seem that this program leaves out many of the factors with which psychology ought to be concerned. Historically considered this is true, but when we are confronted both with the practical and scientific needs of life we are ready to admit that after all what we seek to have psychology busy herself with is just this matter of *environmental adjustment;* what can man do apart from his training; what can he be trained to do, and what are the best methods for training; and finally, how, when the varied systems of instincts and habits have sufficiently developed, can we arrange the conditions for calling out appropriate action upon demand? To answer such questions we must necessarily study the simple and complex things which call out action in man; how early in life he can react to the various simple and complex sense stimuli; at what age he can put on the various instincts and what are the situations which call them out. Just what are the patterns of his instinctive acts, that is, does the human being, apart from training, do any complex acts instinctively as do the lower

animals? If so, what is man's full equipment of instincts? When does emotional activity manifest itself and what are the situations which call it out, and what special acts can be observed in emotional behavior? How soon can we observe the beginnings of habit in infants? What special methods can we develop for rapidly and securely implanting and retaining the body and speech habits which society demands? Do we find special and individual equipments in infants and do these develop and later form the basis for their entering one kind of vocation or another, or developing into one or another type of personality? Are there such factors as habit and instinct conflicts, distortion of habits and emotions? How do they manifest themselves, and is it possible to develop methods for shaping the environment of the individual so that such conflicts will not arise?

Stimulus and Response.—This general description of the subject matter of psychology helps us very little as regards the analysis of particular problems in conduct and behavior. In order to plan an experimental attack upon any problem in psychology we must first reduce it to its simplest terms. If we look over the above list of subject matter and at our practical examples we see that there are common factors running through all forms of human acts. In each adjustment there is always both a *reaction or response* and a *stimulus or situation* which calls out that response. Without going too far beyond our facts it seems possible to say that the stimulus is always provided by the environment, external to the body, or by the movements of man's own muscles and the secretions of his glands: finally, that the responses always follow relatively immediately upon the presentation or incidence of the stimulus. These are really assumptions, but they seem to be basal ones for psychology. Before we finally accept or reject them we shall have to examine both the nature of the stimulus or situation, and of response. If we provisionally accept them we may say that the goal of psychological study is the *ascertaining of such data and laws that, given the stimulus, psychology can predict what the response will be; or, on the other hand, given the response, it can predict the nature of the effective stimulus.*

Use of the Term Stimulus.—We use the term *stimulus* in psychology as it is used in physiology. Only in psychology we have to extend somewhat the usage of the term. In the psychological laboratory when we are dealing with relatively simple factors such as the effect of ether waves of different lengths, the effect of sound-waves, etc., and are attempting to isolate their effects upon the adjustments of men, we speak of stimuli. On the other hand, when the factors leading to reaction are more complex, as, for example, in the social world, we speak of *situations*. A situation is, of course, upon final analysis, resolvable into a complex group of stimuli. As examples of stimuli we may name such things as rays of light of different wave-lengths; sound-waves differing in amplitude, length, phase and combination; gaseous particles given off in such small diameters that they affect the membrane of the nose; solutions which contain particles of matter of such size that the taste buds are thrown into action; solid objects which affect the skin and mucous membrane; radiant stimuli which call out temperature response; noxious stimuli such as cutting, pricking, and those injuring tissue generally. Finally, movements of the muscles and activity in the glands themselves serve as stimuli by acting upon the afferent nerve endings in the moving muscles (p. 341).

It must be emphasized here that only under the rarest experimental conditions can we stimulate the organism with a single stimulus. Life presents stimuli in confusing combinations. As you write you are stimulated by a complex system —perspiration pours from your brow, the pen has a tendency to slip from your grasp. The rays of light reflected from the paper focus the physical image of the words upon your retinæ. The chair offers stimulation—the noises from the street, etc. But far more important, delicate instruments would show that though you are not speaking aloud your vocal mechanisms—tongue, laryngeal muscles, etc., are in constant motion: moving in habitual trains, these laryngeal movements serve largely as the stimuli for releasing the writing movements of the hands. The fact that you are

here in the lecture room facing your instructor and surrounded by your classmates is still another very important element. The world of stimulation is thus seen to be exceedingly complex. It is convenient to speak of a total mass of stimulating factors, which lead man to react as a whole, as a situation. Situations can be of the simplest kind or of the greatest complexity. It should be noted here finally that there are many forms of physical energy which do not directly affect our sense organs. As examples we may cite the facts that ether waves longer than 760 $\mu\mu$ or shorter than 440 $\mu\mu$ do not lead to visual reactions, and that many of the wave motions in the air are of such length or amplitude that they do not produce auditory stimulation. The inability of the human organism to respond to many possible forms of stimulation will be discussed later.

The General Nature of Response.—In a similar way we employ in psychology the physiological term response, but again we must slightly extend its use. The movements which result from a tap on the patellar tendon, or from stroking the soles of the feet are 'simple' responses which are studied both in physiology and in medicine. In psychology our study too is sometimes concerned with simple responses of these types, but more often with several complex responses taking place simultaneously. In the latter case we sometimes use the popular term 'act' or adjustment, meaning by that that the whole group of responses is integrated in such a way (instinct or habit) that the individual does something which we have a name for, that is, 'takes food,' 'builds a house,' 'swims,' 'writes a letter,' 'talks,' etc.[1] In working over the distinctions among the various types of acts the speculative psychologists have introduced many needless technicalities and metaphysical concepts, such as purpose, end, etc. Psychology is not concerned

[1] But it should be well understood that whatever the man does under stimulation is a response or adjustment—blushing, increased heart beat, change in respiration, etc., are definite adjustments. We have names for only a few thousands of the total possible number of such adjustments. The term adjustment is used by most writers to refer to the doing of one of these *named acts*. In this volume the terms adjustment, response, reaction, etc., are used almost interchangeably.

with these distinctions. Because a man fails by his separate acts to get his food, to build his house, to work out his mathematical problem, or to live in harmony with his wife, is no reason for rejecting him as a psychological subject. We study him for his *reaction possibilities and without prejudice:* the discovery of the fact that he will make only abortive attempts to meet and control certain aspects of his environment is an important part of our task; just as important as being able to state that he can make certain other types of adjustment. 'Successful' adjustments, 'good' acts, 'bad' acts, are terms really which society uses. Every social age sets up certain standards of action, but these standards change from cultural epoch to cultural epoch. Hence they are not psychological standards. Reaction possibilities, however, on the average probably remain about the same from eon to eon. It lies well within the bounds of probability that if we were able to obtain a newborn baby belonging to the dynasty of the Pharaohs and were to bring him up along with other lads in Boston, he would develop into the same kind of college youth that we find among the other Harvard students. His chances for success in life would probably not be at all different from those of his classmates. The results obtained from the scientific analysis of reaction in the human being should fit any cultural age. It is part of the function of the psychologist to tell whether a given individual has the reaction possibilities within him to meet the standards of that cultural age, and the most rapid way of bringing him to act in accordance with them. The fact that social values (group *mores*) change puts ever new burdens upon the psychologist because every change in the *mores* means a different situation to which man has to respond by a different combination of acts, and any new set of acts must be incorporated into and integrated with the rest of the action systems of the individual. The problems put up to psychology are those of deciding whether the individual can meet the new standards and for determining and developing methods of instructing him.

Motor and Glandular Indicators of Response.—What is it

that the psychologist can observe? *Behavior* of course. But behavior on analysis is the separate systems of reactions that the individual makes to his environment. When we come to study the mechanics of such adjustments we find that they depend upon the integrations existing among the receptors and the muscles and glands.

The unicellular organisms have no separate muscular or nervous systems. Yet a part of their one cell must be specialized in a motor as well as in a sensory way, since these organisms do move in response to stimuli—to light, gravity, heat, cold, electricity, etc. As you pass higher in the scale special sense organ tissues (receptors) develop and along with them both motor or effective organs, and neurones connecting receptors and effectors. Action in such cases becomes sharper, more localized, more immediate, and at the same time more sustained. Furthermore, as we pass still further up the scale, glands begin to develop. Glands like muscles are responsive organs and special glandular action takes place whenever motor action takes place. The activity of the glands in turn reacts back upon the muscular system and affects its functioning (p. 338). Furthermore, there are two kinds of muscles, striped and unstriped. The striped muscles move the arms, legs, trunk, tongue, larynx, etc. The unstriped muscles control largely the blood vessels, intestines, lungs, etc. Usually when we speak of response we mean that the organism goes forward to right or left, or retracts as a whole, that it eats, drinks, fights, builds houses, or engages in trade. But these patent and easily observable changes do not exhaust the term response, as we pointed out on p. 339. We should mean by response the total striped and unstriped muscular and glandular changes which follow upon a given stimulation. Our problem of the moment determines which movement shall be studied in relative isolation; in man, though, interest has been largely centered in the integration of separate responses; in getting him to form some habit—that is, to do something with arms or legs or vocal cords. It is important to get at the outset a comprehensive notion of response. A child or

animal may stand stock still under stimulation, but we should not say that there was no response. Close observation shows that there are changes in the tension of the muscles, in respiration, in circulation, and in secretion.

General Classification of Responses.—The various possibilities of reaction are thus seen to be vast; so vast indeed that it would seem at first sight as though any classification would be impossible. We can at least find a convenient grouping which will serve us well both for discussion and for setting experimental problems. Most reactions may be looked upon as falling into one of four main classes:

1. Explicit habit responses: as examples we cite unlocking a door, tennis playing, violin playing, building houses, talking easily to people, staying on good terms with the members of your own and the opposite sex.

2. Implicit habit responses: 'thinking,' *by which we mean subvocal talking*, general body language habits, bodily sets or attitudes which are not easily observable without instrumentation or experimental aid; the system of conditioned reflexes in the various glands and unstriped muscular mechanisms, as, for example, conditioned salivary reflexes.

3. Explicit instinctive responses: including man's observable instinctive and emotional reactions as seen, for example, in grasping, sneezing, crawling, walking, etc., and in fear, rage, love.

4. Implicit instinctive responses: this includes of course the whole system of endocrine secretions, changes in circulation, etc., so largely studied by physiology. Here again instrumentation or experimental aid is necessary before observation can be made.

These various types of response will be studied in detail in later chapters. The classification as a whole should be clear with the possible exception of 2, implicit habit responses. This group is so important and so generally neglected in discussion that we shall single it out here for brief mention in advance of the chapter in which it is entered into with some care.

What Man is Doing when Not Overtly Acting.—With a

highly specialized organism like man even careful observation often fails to show any overt response. A man may sit motionless at his desk with pen in hand and paper before him. In popular parlance we may say he is idle or 'thinking,' but our *assumption* is that his muscles are really as active and possibly more active than if he were playing tennis. But what muscles? Those muscles which have been trained to act when he is in such a situation, his laryngeal, tongue, and speech muscles generally.[1] Those muscles are as active and are carrying out as orderly a system of movements as if he were executing a sonata on the piano—they are doing it well or ill depending upon the training he has had along the particular lines which engage him. While we cannot at present watch the play of this implicit stream of words there is no reason for hypothecating a mystery about them. Could we bring 'thinking' out for observation as readily as we can tennis playing or rowing, the need of 'explaining' it would disappear. We shall see later that efforts have been made to bring such responses under experimental control. But entirely apart from our present unreadiness to make observation on implicit habits, we find a certain way of arriving indirectly at the same end: *implicit language habits*, by methods which we shall study, come to issue finally in overt action. By watching the easily observable explicit habits and instincts of an individual keenly enough, and for a sufficient stretch of time, and under varying enough conditions, we can obtain the necessary data for most psychological requirements.

Scientific Methods Contrasted with Practical Procedure.— Having now examined at some length into the general nature of both stimulus and response, we should be prepared to understand the object of a psychological experiment and to contrast the scientific procedure with the common sense or practical procedure which we discussed at the beginning of the chapter. We shall take up almost at random some definite illustrative psychological problems and the methods of solving them. Our first problem is *to find out what the*

[1] Indeed the whole glandular and muscular systems are contributory.

reactions of a six-months-old infant are to living furry animals. We first arrange the situation (complex group of stimuli). The infant is held by its mother in a well-lighted room. We observe first that the infant is smiling and comfortably disposed. Then one after another we present a white rat, a dog, a cat, a white rabbit, beetles, and a snake. We next record accurately and separately the responses to these objects. The infant, which has only learned to reach out for objects a short time before, slowly puts out first one hand and then the other. The smile leaves his face but no crying or withdrawing of the hands or external secretions follow. These are only the more easily observed responses. Other changes take place undoubtedly, in the internal glands, circulation, respiration, etc. It depends upon our immediate problem as to where the emphasis in observation shall fall in our record of reaction changes. In this case our problem was to determine whether there were any overt instinctive tendencies on the baby's part to react against or withdraw the hands or whole body from live animals. Our problem might very well have led us into observing the changes in the eyes, respiration, blood pressure, salivation, or in the endocrine glands, or in several of these at once. Again it should be noted that our problem is not so simple as it seems at first sight. Suppose we had found that the baby did withdraw from the objects, began to cry, void urine, or attempt to hide behind the mother's clothing—could we have concluded that there was an instinctive reaction against live furry animals? *Not without delving into the baby's past.* If we had had the child under constant observation and found no record of previous acquaintanceship with live animals, our answer would be that the observable responses were probably instinctive. But if on the other hand we found that the child had been severely bitten by a cat only two days before our test, our conclusions would have to wait upon more extended observation. Nor can we, from the behavior of this one child, draw any conclusions as to what other children of the same age will do, or what this child might do at a slightly different age or when tested under different conditions; before general-

izations can be made many children should be brought under systematic observation.

As another example of a somewhat more restricted type, let us take the case of a man whose everyday behavior has led us to suspect the normality of his responses to monochromatic (colored) light. Common sense has nothing to say; it can give no adequate report upon him. His mistakes may be due to one or many things. We take him into the laboratory where monochromatic light is under control and we put him in situations where he has to react to the lights in pairs, and where each one of the lights can be widely varied in energy. In the course of the investigation we find that when there is a certain energy relation obtaining between the red and the green lights he can no longer react to them differentially (that is to say, they do not offer different stimulating values). We note further that we can find a white light of a certain intensity to which he reacts as he does to either of the monochromatic lights. But at no energy relation between any other two colors can we break down his differential responses. We conclude after this careful study that the man is red-green blind, that is, that he reacts to red and green as he does to certain intensities of white light.[1] Let us take another example, and this time from the field of vocational psychology. Suppose that the telephone directory of a large city is getting entirely too bulky and complex for men to handle easily. What is the best method for obviating this? The telephone people and the psychologists work together. The psychologist may suggest printing in smaller type and four columns to the page instead of three. These and many possible suggestions may lead to a solution of the problem. But the matter has to be put under severe trial both before individuals trained to look up names in a directory and before individuals having no more training than has the general public. *Syste-*

[1] If we find by repeated tests that the anomaly is more than temporary, we are right in advising this man that he will be handicapped if he enters certain occupations, *e. g.*, locomotive and marine engineering, geology, advertising, etc. In other words, the results of psychological experimentation are as immediately practicable as are results in any other scientific field.

matic trial and error is the procedure here with statistical treatment of the results. In the end it is found that a four-column page with a certain amount of spacing between the lines of print makes the directory not only 20 per cent. less bulky but also one in which the subscribers can find names 10 per cent. more rapidly.

The Divisions of Psychology and the Relation of Psychology to the Other Sciences

The Various Fields of Psychology.—It is just as difficult to draw a hard and fast line between the different branches of psychology as between the different branches of biology and physics. Practical and theoretical interests determine where a man will throw the emphasis of his observation. All scientific psychology is experimental, or is at least carried out under such conditions that rigid and controlled observation is possible. All psychology is 'genetic' in the sense that we have to go back to the child and contrast it with animals in order to determine what native systems of integrations belong peculiarly to man. For purposes of specialization we speak of human psychology as being made up of *individual*, *vocational*, *child*, *folk*, *educational*, *legal*, *pathological*, and *social* psychology. For our purposes we need not enter into a separate characterization of these special branches. The remaining chapters in this book attempt to deal generally with the simpler results, problems, and methods in common use in psychology. We shall not emphasize, except here and there, the particular branch to which such material belongs.

Relation of Psychology to Physics.—Both physiology and psychology are dependent (as is every other science at bottom) upon physics for the control of apparatus and of stimulus. It is essential for a research student in psychology now to know the general facts about wave motion; as, for example, heat, sound, and light. It is important to know how to install and use simple electrical instruments, galvanometers, thermal couples, and photometers.

Relation to Neurology.—It might be supposed that psychology would lean most heavily upon neurology. Indeed

this has been the general assumption in the past. Psychological texts have been overburdened with cuts and descriptions of the nervous system and we have many works which claim on their title pages to be physiological psychology. Gradually we are gaining the point of view that the psychological laboratories cannot teach both psychology and neurology. Where a neurological laboratory is at hand training in neurology should certainly be included, but it is doubtful if much can be gained by a psychological student from merely looking over cuts and listening to lectures on the subject. Some notion of the elements involved in reflex arcs is certainly essential—the way sense organs are connected with the central nervous system and the central nervous system with the muscular and glandular systems. In a later Chapter we touch upon some of the more elementary features connected with the arrangement and functioning of reflex pathways.

Relation of Psychology to Physiology.—It has been claimed by some that psychology is really physiology. That this is not the case appears from even a casual examination of the respective scopes of the two provinces. Physiology teaches us concerning the functions of the special organs. For purposes of experimentation and exposition the heart, liver, lungs, circulation, respiration, etc. are isolated, or are at least discussed as isolated functions. All of the functions of the bodily organs are gone over in this way. Muscle-nerve preparations are taken out and their properties investigated. It is not meant to assume that physiologists deal wholly with organs in isolation. Certain combined processes are studied, such as metabolism, digestion, effects of poisons, etc., but nowhere in physiology do we get the organism, as it were, put back together again and tested in relation to its environment as a whole.

From our discussion of the scope of psychology we are now prepared to see what when the physiologist has learned all that he can about the functioning of the separate organs of the body of man, he has encroached upon our field only in a very slight degree. Our task begins only when the

physiologist puts the separate organs together again and turns the whole (man) over to us. The physiologist *qua* physiologist knows nothing of the total situations in the daily life of an individual that shape his action and conduct. He may teach us all there is to know about the mechanism of stepping, but it is not his task to determine whether man walks before he crawls, the age at which walking begins, whether walking begins earlier in boys than in girls, or whether defective children walk at a later age than normal children. Again, he may teach us a great deal about the functions of the kidneys, the bladder, and of the sphincter control of the latter; but of the special situations (outside of disease entities) which may lead to incontinence in children, his science teaches him nothing, nor of methods of controlling this mal-adjustment. In studying psychological functions, for example, the emotions, it does not help him very much to try to picture what chemical and neural processes go on in the brain. It has often been asserted, *e. g.*, that the thalamus is operative in emotional disturbances. We do not get very far, though, by trying to picture such activities, or by speaking of what goes on in the individual neurones. We get a very incomplete but a somewhat better view if we consider what goes on in glandular action during emotional states. But even glandular action is not easily observed by methods which are known today. We can, however, study the reaction states we popularly call sadness, elation, moroseness, rage, fear, love, etc., from the standpoint of what the organism can do in these states and as to whether the smooth running of the general system of organized habits is facilitated or disturbed by the presence of emotional activity. We can, further, often determine by a study of the life history of the individual how frequently such disturbances come about and can trace out the causes or factors leading to their onset. Physiology has nothing to tell us of the character and personality of different individuals nor of their emotional stability or lack of emotional control, nor as to what extent their present place in life is dependent upon their upbringing. Physiology tells

us nothing of man's capacity to form and retain habits nor of the complexity of man's habit organization. Hence if we wish to predict whether an individual is capable of rising above the environment to which he is not adjusted, we should have to go to psychology and not to physiology for our answer. In thus emphasizing the entire theoretical independence of the two fields let us not set up a false impression of antagonism. Physiology is psychology's closest friend among the biological sciences. We can hardly move a step in psychology without using physiological data. But in this we are not different from the other biological sciences, or indeed from medicine itself.

Overlapping of the Two Fields.—Occasionally we find physiologists who have dealt with functions which overlap the field of human behavior. As examples, we cite the work of Cannon on the bodily effect of violent emotional disturbances, and of Carlson and others on the question of the reactions which are present in the stomach in the absence of food. Where the two fields overlap most, however, is probably in the study of the nervous, muscular, and glandular systems, and in the realm of sensory physiology. This latter topic no longer seems seriously to interest the physiologists, and where they have shown interest in it, in this country at least, it has been mainly pedagogical. Most of the work in sensory physiology has been done by psychologists. Until the recent work of Pavlow and Bechterew and their students physiologists have shown little interest in the study of habit formation, which general topic is one of our central ones. In general it may be said that there is some overlapping in the two fields, but that this does not keep them from being separate disciplines. In cases where there is an overlapping the methods and points of view of the two sciences in no wise differ.

Relation of Psychology to Medicine.—Up to the present time psychology has been of only slight service to psychiatry and medicine generally. It should form a background for the whole field of medicine. But it has dealt hitherto so largely with speculations and with philosophical considera-

tions that its usefulness for this purpose has been seriously restricted.

The physician, whether medical specialist or general practitioner, would like to know something about the method of approaching and handling his patients. He must encounter—and he must be prepared to encounter—such things as stubbornness and unyieldingness in his human subjects, and he must learn to study his patients in relation to their present environment, and to go back into their life history for an understanding and explanation of such attitudes. He must learn how to size up his patients and to get at the details of their individuality and characteristics. He must be able to tell whether the patient can do what he is told to do, and whether he has sufficient assets to meet the environment in which he has to live, and whether he has sufficient assets to rise out of the environment which is unsatisfactory to him. These facts on character adaptation cannot be expressed in any other terms than behavior terms. These are, to be sure, factors which concern everyone who has to deal with his fellow-man, but on account of the intimate relationship existing between the patient and his physician they are of especial importance to the latter. The psychiatrist has not neglected these factors; indeed, it has been due to him that they have been emphasized at all, and it is largely through his efforts that we have a well-developed and systematic technique for isolating the factors of importance in the life history of the patient. In so far as psychiatry is concerned I think we can say that the psychology the psychiatrist uses is not different from the psychology we are trying to study. The psychiatrist has to be both a physician with a specially developed therapeutic technique, and a psychologist with special interests in certain divisions of psychology. Psychiatry has no special need for detailed studies on reactions to sensory stimuli. Much of the detailed work on habit formation and on the separate analysis of instincts is not of special use to him. On the other hand, any of the material which the psychologist may offer on the subjects of attachment and detachment of the emotions, on the

genesis of instincts and habits and their interrelations, on the effect of age, drugs, etc., on habit formation and retention, upon false reactions and failures in reactions, on the effect of lesions of the central nervous system in trained animals and the resultant success that comes from retraining them, can be utilized by the psychiatrist at once, both in a specific way and by reason of its value in helping him to size up his patients. Most psychiatrists will admit that when the proper kind of psychology is developed they can utilize directly a large part of both of our methods and of our materials. This appears clearly when we examine the various tests which have been devised by psychologists for evaluating the general behavior levels of individuals. Such tests in one or another form are in common use in every psychiatric clinic. Topics such as 'general behavior,' 'stream of talk,' 'attitude,' 'orientation,' 'retention' of recent and past happenings, 'general information,' the emotional level at which acts can be carried out, etc., are discussed in relation to every patient admitted to a psychiatric clinic.

Preparation for Psychology.—In dealing with the native equipment of man the student of human psychology will find a background of study of animal behavior a helpful one. As a further preparation for this part of his work he will find that he needs some equipment in physiology and experimental zoölogy. His work in habit formation leads him again into physiology and pharmacology for such factors as the effect of age, drugs, etc., upon the human organism. The consideration of habit and instinct conflicts, abortive reactions and failures of adjustments generally which we see so well emphasized in tics, sympathetic chorea, hysteria, obsessions, etc., leads the psychologist into the psychiatric clinic if he wishes to prepare himself to the fullest extent. Business and law are making ever and ever larger demands upon him. Some familiarity with legal and business problems is almost essential. Finally, in order to handle adequately experimental data some training in the use of statistical methods is needed. If a start is made early enough by the student who is preparing for psychology he can obtain the

above related branches before he begins his special study of psychology. While today is a day of specialists it should not be a day of narrow specialists. The tendency to have information about one small corner of psychology should not be encouraged. It leads to such anomalies as pure "mental testers," psychotechnicians, and the like.

RELATION BETWEEN FUNCTIONAL AND BEHAVIOR PSYCHOLOGY

BY A. P. WEISS

Ohio State University

The concept of evolution in biology supplemented the purely descriptive and systematic accounts of plants and animals by the introduction of a genetic and developmental factor. So fruitful did this new outlook prove to be and with such audacity and effectiveness did it probe into the cherished beliefs of orthodoxy that even man's mind became the object of prying research. Psychology was no longer content to study the structure of mental states, but its interests expanded so as to include the development and genesis of mind. As experimental methods became more prevalent, the practical needs of pedagogy stimulated interest in the relationship between mind and action, and this in turn resulted in a more critical analysis of behavior or conduct. Finally the axiomatic character of the proposition 'Mind controls action' was challenged and this introduces one of the controversial points of modern psychology.

Problem of Functional Psychology

The causes which led to the point of view called functional psychology were the need for a more dynamic principle in the explanation of human behavior than was offered by the descriptive and systematic accounts of the nature of mind as given by the structural psychologists. That the study of the mind was of great value in understanding human behavior had never been questioned, but the lack of uniformity in terminology and the controversies on methodology made it practically impossible to formulate the problem of the relationship between mind and action in such a way that it could be critically discussed by any considerable number of psychologists. As the investigations of the sense

organs and of the nervous system increased the body of fact available for the development of hypotheses, the original definition of psychology as the science of consciousness was extended, in spirit at least, to include the neural correlates of conscious processes.

William James[1] was one of the earlier psychologists in the country who clearly foresaw that the investigations into the relationship between the psychological faculties and human conduct had been neglected. The shift of the emphasis from the systematic treatment of consciousness to the investigations of the *conditions* under which consciousness manifested itself, may be regarded as the starting point of the *functional* point of view.

Briefly, the problem of functional psychology may be expressed in the question: How does consciousness function in human behavior or conduct?

Problem of Behavior Psychology

The origin of behavior psychology was largely due to the fact that functionalism failed to indicate the manner in which a conscious process could be regarded as controlling behavior. Neither the parallelism nor the interaction of conscious processes and physiological processes did more than indicate a possible relation. These theories did not show how behavior was actually modified. The question, whether an idea or conscious state could bring about action appropriate to the idea was denied by many. Some psychologists even concluded that no form of consciousness whatever could alter the direction of a neural flux, and consequently mere consciousness was not a factor in behavior or conduct. This inevitably led to the question as to how human behavior did actually come about and those psychologists who questioned the causal effectiveness of consciousness, formulated their problem in the following manner: How may the behavior of man (or animals) be described as *solely* due to receptor-effector processes in the neuro-muscular system.

[1] 'The Principles of Psychology,' 1890, Vol. 2, p. 1.

"They (sensations and perceptions) are therefore names of different cognitive *functions* not for different sorts of mental *fact*."

Conscious Processes as Metaphors

The lack of precision and accuracy in the terminology of the functionalists was one of the contributing causes in differentiating behaviorism from functionalism. The *function* of consciousness in behavior was accepted as a self-evident fact that needed no proof. "That they (mental phenomena) lead to acts is of course the most familiar of truths, etc."[1] This was, of course, merely a modified form of faculty psychology in which the term mind or consciousness was substituted for the term faculty. The following quotation is representative of the attitude of many functionalists so far as the practical applications of psychology are concerned.

"The formation of the elements of the process of knowledge and the inauguration of the control of our movements in accordance with the mandates of experience—these are the two great functions of perception."[2]

If this quotation is taken literally, then "perceptions" must be regarded as entities which inaugurate and control our movements. A faculty of 'perception' is, however, just as unscientific as were the entities of reasoning, poetry, foresight, etc., of the faculty psychologists.

We are warned, however, that the quotation is not to be taken literally but that the faculty implication is merely assumed to avoid an involved and cumbersome terminology.

"Let it be understood once and for all that wherever we speak, as occasionally we do, as though the mind might in a wholly unique manner step in and bring about changes in the action of the nervous system, we are employing a convenient abbreviation of expression which harmonizes with ordinary everyday methods of thinking and speaking about these relations. The real fact appears to be, that whenever we have mental activity we also have neural activity in the cerebral cortex. The basal distinction in the two kinds of nervous action to which we are referring in this chapter (mind, neural action and habit) is, therefore, not primarily

[1] James, Wm., 'Principles of Psychology,' 1890, Vol. 1, p. 5.
[2] Angell, J. R., 'Psychology,' New York, 1908, p. 171.

between a form in which the mind suddenly produces changes in the nerves as against one in which it does not, but rather a distinction between certain kinds of neural activity overtly involving consciousness, *e. g.*, cortical activity of the cerebrum, and certain other kinds not overtly involving it, *e. g.*, spinal reflexes. To use on every occasion the long modifying phrases necessary to precise accuracy on this matter would evidently be unduly cumbrous, and so the commoner modes of expression are employed, but the fundamental facts which lie behind these convenient metaphors must not be forgotten."[1]

One might very well condone a lapse from the "long modifying phrases necessary to precise accuracy" into the "occasional use of convenient metaphors," but when the precise accuracy is restricted to a few paragraphs and the occasional metaphors make up the body of the book, one is led to wonder whether the principle of faculty psychology may be considered repudiated.

Passing aside the question as to whether a textbook written in metaphors can be said to present its subject matter scientifically, the more important question as to what are the principles which underlie the functional point of view as implied in the preceding quotation, may be formulated as two propositions:

1. There are certain neural processes which overtly involve consciousness; *e. g.*, cortical activity in the cerebrum.

2. There are certain neural processes which do not overtly involve consciousness; *e. g.*, spinal cord reflexes.

It is difficult to see how these two propositions may be used to convert the metaphors of the following quotation into the precise accuracy that is necessary for scientific understanding.

"Perception enables its possessor to register in consciousness the particular object momentarily presented to the senses. But if consciousness never advanced beyond the merely perceptual stage it is apparent that we could never develop any highly systematized and intelligent movements of response to environmental demands and opportunities.

[1] Angell, J. R., 'Psychology,' New York, 1908, p. 59.

Intelligent deliberation would be impossible. We should always live in the immediate present and our minds could consciously look neither backward nor forward. Now it is in the image with its ability to carry such prospective and retrospective meanings that we find the psychical mechanism for accomplishing both these highly important functions."[1]

The writer does not wish to imply that the functionalists are the only group of psychologists who write essays rather than scientific expositions. On the contrary the preceding quotation on the function of perception is considerably clearer than many of the explanations of the functions of mental activity which are to be found in the literature of educational and applied psychology. Nevertheless, just as long as we excuse ourselves on the plea that others do it, and persist in substituting rhetoric for science, we should not complain if our work is regarded with suspicion by the biologists.

Consciousness and Behavior

Returning again to the fundamental principle underlying functional psychology, namely, 'that it is mental activity rather than mental structure that is of immediate significance for thought and conduct' we will make an attempt to illustrate just what sort of a relationship must exist between consciousness and behavior if the claims of the functionalists are to be substantiated by science.

The form of representation in the following figure is that usually used to illustrate the theory of psychophysical parallelism in which action is the result of the stimulation of a receptor (*S*) of some sort. The nervous excitation which results is transmitted over neurons indicated by solid lines in the direction of the arrows, to effectors (*M*) which may be either muscles or glands. When the nervous excitation reaches these effectors contraction occurs in the case of a muscle, and secretion in the case of a gland. Consciousness in the form of sensations, images, affections, volitions, emotions, etc., are indicated by the dotted lines. This consciousness is thought of as accompanying the neural processes.

[1] *Op. cit.*, p. 215.

The illustration thus represents the neural processes and the conscious processes which are said to be correlated with them.

The diagram below represents the neural and conscious conditions in the following situation: The subject is passing along a familiar road and suddenly comes upon a loose wire dangling from a telegraph pole. Let the solid lines between *Sa–Ma* represent the neurons which connect the eyes with the muscles that bring about the activity of walking. The conscious processes which may occur with the walking are represented by the dotted line parallel with *Sa–Ma*. If the

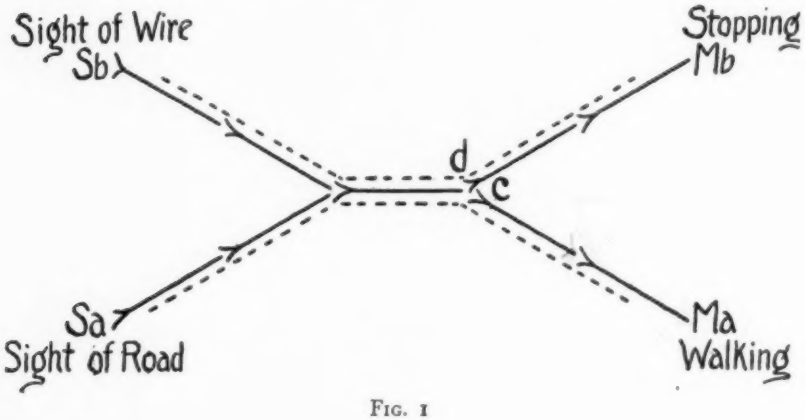

FIG. 1

activity of walking is completely habituated there may be no conscious processes which can be readily analyzed. Let the solid lines *Sb–Mb* represent the neural processes from the eyes to the muscles which result in stopping, supposing this is what happens as soon as the wire is seen. These muscles may of course be partly the same as those used in walking, but since walking and stopping represent different forms of behavior, they have been differentiated in the diagram. The dotted line parallel to *Sb–Mb* again represents the conscious processes which are correlated with the neural processes. For any given individual the elementary constituents (sensations, images and affections) of the consciousness will vary but by referring to it as the 'idea of danger' (from an electric shock) its characteristics are sufficiently

described for our purpose. Let this 'idea' be represented by (*d*) on the diagram.

If consciousness controls behavior the functionalist must show how the idea (*d*) acts on the neural processes *Sa–Ma* and *Sb–Mb* so that *most* of this neural flux will go to *Mb* instead of *Ma* as was the case before the 'idea' appeared in consciousness. To do this (*d*) must be regarded as acting on the neural processes at some point, say at (*c*). The problem is simply this: What is the character of the psychical mechanism which will enable us to understand how a psychical process (the idea) can influence or change a neural process.

The functionalist cannot consistently accept the principle of psychophysical parallelism in which the conscious process merely accompanies a neural process without acting on it, since this would repudiate the possibility of consciousness influencing action. Some of the functionalists accept the principle of psychophysical interaction and believe that the 'idea' does in some way 'switch' the neural processes, though they frankly confess that they do not know how it is done.

It might be well to call attention to the fact that the diagram is general in character and that (*d*) may represent any conscious process whatever. In the illustration (*d*) is regarded as a perceptual process, but some functionalists maintain that the affective processes (satisfaction and annoyance) are the only ones which modify behavior; others would ascribe this modifying capacity to the emotions (fear, rage, sentiments, etc.); while still others substitute volitional processes (will, desire, wishes). The problem, however, to show just in what way these conscious processes act upon the neural processes is the same for all and for us it is only necessary to call attention to the solidarity with which they one and all agree that they do not know how this interaction takes place.

The most comprehensive attempt to show that conscious processes should be regarded as having the power to modify or control neural activity has been made by Wm. McDougall, who finally reached the conclusion that "Of the limits of the power of mental control over organic processes of the body

we are altogether ignorant, and new evidence, much of it ill reported and therefore valueless, but much of it above suspicion, repeatedly warns us against setting up any arbitrary limit as to what may be effected in this way."[1]

Most psychologists would be content to determine the limits of the power of mental control over organic processes after it had been demonstrated that such control was an actual fact. It seems strange that the functionalists have never recognized clearly that they cannot expect any considerable degree of scientific recognition until they have developed a working hypothesis which will enable them to analyze any experience into those mental and physical components which are the *essential* condition of the experience.

This has been a rather difficult task for those who have tried it and a few functionalists have gone so far as to repudiate psychophysical interaction. For the latter only two alternatives remain: First, the investigation of conscious processes as such, without reference to behavior; or the point of view of structuralism. Second, an investigation of behavior independently of consciousness; or the viewpoint of behaviorism. Functionalism can only claim an independent point of view when it has shown how a mental process may act upon a neural process.

The Neural Correlates of Consciousness and Behavior

The relationship between consciousness and action toward which functionalism seems to be moving regards the *neural correlate* of consciousness, rather than consciousness as such, as the factor that modifies action. In other words, when the functionalist states that the function of perception is to control action, this means that it is the *neural correlate* of perception that controls action.

Referring to the diagram of Fig. 1, this would mean that the individual does not stop because the 'idea of danger' (*d*) acts on the neural processes so that most of the flux reaches *Mb* (stopping) but that the 'idea of danger' had as

[1] McDougall, Wm., 'Body and Mind,' New York, 1911, p. 375.

its neural correlate the processes *Sb–Mb* and it is this neural process (not the idea) which brought about the stopping. This is more clearly illustrated in that phase of functionalism in which the affective processes[1] (satisfaction and annoyance) rather than the perceptual functions are regarded as significant for behavior. The neural correlate for satisfaction is held to be the 'readiness of a neuron to conduct' and the degree of conductivity is measured by the "relief of interference with the life processes of the neurons concerned."[2] This theory seems to imply rather clearly that it is the neural correlate of satisfaction (readiness of the neuron to conduct a nervous process) rather than the subjective satisfaction that modifies the behavior.

It is rather difficult to represent this view on a diagram such as Fig. 1. The conscious process of satisfaction may be represented by (*d*) and the 'readiness to conduct' would then refer to the reduced resistance over the path *Sb–Mb*. However, that there is a "relief of interference with the life processes of the neurons" can only be maintained when it has been demonstrated that the reaction *Mb* does actually occur. Since we have no direct way of predicting the metabolic conditions of the neurons, to *infer* from the reactions that there has been a "relief of interference with the life processes of the neurons" does not help us to understand how the increased 'readiness to conduct' has been brought about. This, of course, is the problem.

Whether we regard the neural correlate of either cognition or affection as significant for behavior, the fact remains that the conscious processes themselves cannot be regarded as significant, because they cannot occur until the neural conditions have been prepared. That is, at best the conscious

[1] Thorndike, E. L., 'Animal Intelligence,' New York, 1911, pp. 244.

This quotation has been selected because it represents a point of view which ascribes causal effectiveness to the conscious processes of pleasantness and unpleasantness rather than to perceptual processes. The actual working hypothesis of Thorndike is however much better expressed by the following quotation, which is however behavioristic rather than functional in principle:

"Every response or change in response of an animal is then the result of the interaction of its original knowable nature and the environment," *op. cit.*, p. 242.

[2] Thorndike, E. L., 'Original Nature of Man,' 1913, p. 225.

processes merely indicate that the neural conditions for action have already been established. The mental processes themselves are no assurance that the appropriate action will actually take place nor do they indicate how the neural conditions for the action which actually does take place have been prepared.

In other words, the conscious processes *follow* the neural processes, they do not *lead* them.

To learn how the neural correlates of conscious processes come to have the configuration which they do, can only be done by considering the properties of the neuro-muscular system.

Some of the functionalists recognize this clearly enough as a general principle, but in the actual development of their subject matter they drop into the terminology of psychophysical interaction so naturally and with such abandon that one cannot help but feel that the introductory emphasis on neural function is a protective measure against criticism rather than a working hypothesis.

The Neural Correlate of Consciousness and the Neural Correlate of Behavior

The element of greatest confusion in the relationship between consciousness and action is probably the fact that consciousness has always been regarded as an existential datum entirely distinct from action or behavior. Whatever may be the metaphysical principles involved in the mind-body problem, from the standpoint of science, consciousness must be regarded as a reaction. When an observer reports that he is conscious of 'danger' this only means that the muscles of his speech mechanism have contracted in such a way that sounds which we call words and sentences are produced. If the observer does not react in some way, we cannot infer that he is conscious. That is, unless the mental process is expressed by speech (or some equivalent action) this mental process can never become available for science.

Consciousness, as a scientific concept, may be regarded as merely a supplementary reaction of a specific type to a

given situation. If for instance I am asked "What is seven times sixteen?" I may, after some hesitation, simply pronounce the words "One hundred twelve." If then I am asked to give my introspections, I may add: "I had a visual image of the figures 7×10 followed by the visual image of 70 written on a blackboard; this was followed by the auditory imagery—seven times six . . . forty two . . . ; then I had auditory images with kinesthesis of the speech mechanism—seventy . . . forty . . . hundred ten . . . two . . . hundred twelve . . . visual image of 112 written on the blackboard."

We must note that there are two sets of stimuli: (1) What is seven times sixteen, (2) Give your introspections. We should therefore expect two different reactions. Why should we say that the second reaction (introspection) is of an altogether different type than the first? Every one will immediately admit that it is absurd to say that the response to the second stimulus controlled the reaction to the first. The facts in the case are more scientifically stated when we merely regard the introspective reaction as only one of the responses which might be expected in a situation of this kind. It no more controls or determines the many other

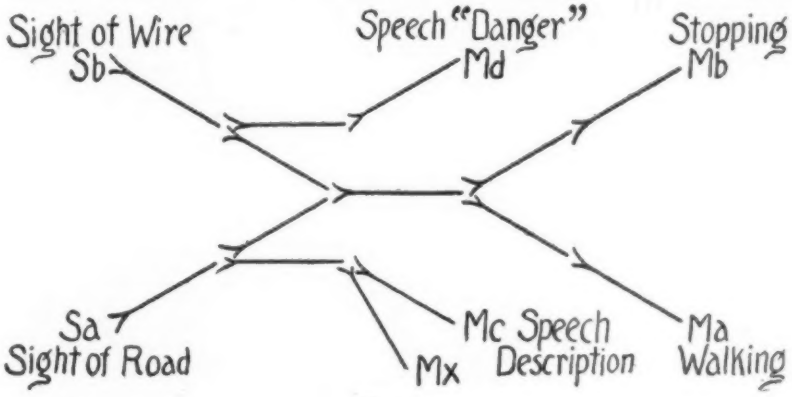

FIG. 2

responses that might have been made, than they control it.

The above diagram (Fig. 2) shows the road-wire situation illustrated in Fig. 1, but drawn as a number of reactions without any hypothetical conscious processes.

When the stimulus is *Sb* the observer not only stops walking (*Mb*) but he may also say: "That wire looks dangerous, I have had one electric shock; last summer Mr. X was killed in this way;" as indicated by the speech reaction *Md*. It is not necessary to conclude that being able also to react by speech (introspection) has anything to do with stopping (*Mb*). The only essential condition for stopping is the stimulus *Sb*. The speech reaction *Md* has nothing to do with it.

Before showing the relationship between the neural correlate of consciousness and the neural correlate of behavior we will consider the terms 'major' and 'minor' reaction. We will assume that every stimulus or situation to which an organism adjusts itself, may result in more than one reaction.

Major reaction: In the first place we have the reaction which is regarded as the appropriate reaction or adjustment to the particular situation. In our illustration this would be 'stopping' (*Mb*) when the wire is seen.

Minor reaction: Secondly, there are also other reactions such as vasomotor; respiratory; changes in the accommodation of the sense organs; speech reactions, both actual and incipient; etc. In our illustration these minor reactions may be a verbal exclamation or introspection (*Md*); decrease in respiration rate; increase in pulse rate; or any of the many bodily and visceral changes which might be described.

Simply stated the major reaction is the one which is significant for behavior, while the minor reactions are those which are usually disregarded. In this sense the introspective report would be called a minor reaction. In the diagram Fig. 2, *Ma* and *Mb* are major reactions; while *Mx*, *Mc*, *Md*, are minor reactions. The difference between Fig. 1 and Fig. 2 lies in the fact that the dotted lines in Fig. 1 which are supposed to represent hypothetical conscious processes have been replaced by neural processes. In Fig. 2 the conscious process of the 'idea of danger' (*d*, Fig. 1) is represented as the speech reaction *Sb–Md*. That it must be some kind of a reaction if it is to be regarded from the scientific standpoint seems clear when we reflect that conscious-

ness which is not *expressed* in some form of reaction, can never become available for science. It is absurd to say that we may have conscious states to which we do not react. The statement itself is a reaction. If we admit this, then every conscious state or process is a reaction. The statement that I have the 'idea of danger' or am 'conscious of danger' only means that in addition to reacting to the sight of the wire by stopping I also react to it by saying, "I must be careful; that wire may be charged; etc."

That this speech may not actually take place is due to the fact that under ordinary conditions we do not react by speech when we are alone. If we have some one with us, a child perhaps, the reaction would take place as a warning or protective movement of some sort. The minor speech reaction *Sb–Md* (which is the only way in which the term consciousness can have a scientific meaning) need have no control or influence over the major reaction *Sb–Mb*. In fact either *Md* or *Mb* might very well occur independently. They are related only through the receptor *Sb*.

From the preceding we can conclude that every stimulus which effects the organism results in more than one reaction. Only one group, however, is usually regarded as socially significant (behavior) and we have called it the major reaction. Along with this major reaction there are many minor reactions and those of the speech type are very numerous. There is no need, however, to believe that these minor reactions are necessary for the adequate functioning of the major reaction.

Consciousness and Introspection

From what has preceded, introspection is merely a name for a group of speech reactions which conform to a particular terminology. While we are introspecting we not only react to a given situation in a manner appropriate to the situation (pressing a key for instance) but we also react by speech in the terminology of psychology. The functionalists have not recognized that the introspective reaction is a minor reaction. The social significance of the major reaction has obscured the fact that introspection itself is only one of the reactions

to the particular situation. They have assumed that in some way it reveals what is taking place in the neural correlate of the major reaction. The development of this introspective reaction is a process of habit formation just as any other variation of response. It is not the expression of a metaphysical entity (consciousness) that has been added to the major reaction.

The only difference between psychological observation and observation in the natural sciences lies in the fact that in psychology the introspective reaction is regarded as the major reaction, while in the natural sciences it is regarded as a minor reaction or ignored entirely. However, neither the major nor the minor reactions can be said to control or modify each other and in this sense there is no mind-body problem.

Functionalism Obscures the Nature of the Psychological Problem

It is not supposed that the nature of the preceding discussion will be considered especially new by the functionalists. Their excellent experimental work in pedagogy and the emphasis they place upon habit formation irrespective of any subjective implication, indicates that practically at least they are following behavioristic methods.

The importance for general psychological theory as to whether human behavior is regarded as the result of the interaction between a hypothetical consciousness and neural processes or as the result of neural mechanism only, lies primarily in the fact that the experimental program will reflect which of these points of view is adopted.

If, as the functionalists assume, consciousness can modify behavior, then to bring about socially acceptable behavior in the child, for instance, it is only necessary to bring about those forms of consciousness which are effective. The problem then becomes one of teaching 'ideals.' From the pedagogical standpoint an ideal must be regarded as a plan of action or conduct. If the expressions of consciousness are used as a test as to whether a given set of ideals has been established there will be a tendency to place undue emphasis

upon verbal expression, since where a serious attempt is made to determine the character of consciousness introspection must play an important part. The problem of teaching ideals then becomes one primarily of establishing formal speech reactions to given situations. While for many situations in life a speech reaction is the adequate reaction there are, however, many other situations in which speech alone is inadequate, as for instance in many ethical relations. In such instances the verbal expressions of the ideals are no assurance that the socially valuable reaction has been learned. On the other hand the socially desirable reaction cannot be learned by merely establishing the speech reaction which *describes* the appropriate behavior. The behaviorist maintains that it is better to disregard the concept of consciousness altogether and the pedagogical problem then becomes one of determining exactly how socially acceptable behavior is developed directly from the properties of the neuromuscular system. If a verbal reaction is part of the appropriate adjustment, well and good; it must be learned. However, after it has been learned there is no advantage in assuming that this verbal reaction is the function of a hypothetical psychical process.

Behaviorist Program

Perhaps the distinguishing difference between the functionalist and the behaviorist lies in the fact that the behaviorist disregards the entity which the functionalist calls consciousness. This does not mean that the behaviorist ignores those problems in behavior with which the concept of consciousness is usually associated. On the contrary by regarding man as an organism he believes that even the most complex problems can be described and explained without assuming the existence of any causes which are not already accepted by science in general. The behaviorist's principal interest will be the movements of man whether these movements are of the skeletal muscles which carry his body from place to place or the movements which result in the composition of a symphony. He regards the neuro-muscular

system as the means by which the organism adjusts itself to its environment, just as the heart, the lungs, digestive tract, are means to keep the organism alive. To withdraw the hand from the scorching candle is a movement of only less complexity than the movements of the pen that signs a treaty between nations. The real object of worth for the behaviorist is not the thrilly, fascinating, esoteric, pseudo-problems of the mystic, but the permanent, measured and describable adjustments of the race.

Summary

1. The axiomatic character of the statement 'Mind Controls Action' is questioned by the behaviorists.

2. The metaphorical explanations of the functionalists obscure the 'faculty' character of their 'mental activity.'

3. The functionalists have never shown how mental activity may control action.

4. The conscious processes of the functionalists actually follow the conditions which bring about a modification in behavior and hence cannot be said to control behavior.

5. Consciousness and introspection to have any scientific value must be regarded as speech reactions which are restricted to the terms used in psychology. The presence or absence of these classes of verbal reactions in no way influence the socially significant reactions.

6. The difference between the natural sciences and psychology lies in the fact that psychology restricts its observations to those special speech reactions (introspections) that conform to the terminology of psychology. In the natural sciences this class of verbal reactions is ignored.

7. The concept of a hypothetical conscious process obscures the real problems of psychology.

8. Behaviorism regards the introspective reaction as only one of the ways in which an individual may react to a situation.

THE RELATION BETWEEN EMOTION AND ITS EXPRESSION

BY HARVEY CARR

University of Chicago

This paper proposes a conception of the nature of an emotion in relation to its expression which constitutes somewhat of a compromise between the theory of James and the older view which it displaced.

The popular view assumed that some inner or central emotional experience follows the act of perception, and that this emotion is succeeded by a complex series of organic disturbances. The inner activity is the emotion and the resulting organic change is the expression of that emotion.

James denied the existence of any centrally conditioned process intervening between the perception and the organic activities which may properly be termed an emotion. James asserted that the terms emotion and expression must refer to distinctions within the series of organic activities aroused by the perception, and that these activities are sensory and peripheral in character. As is well known, James dichotomized these psychophysical activities into their conscious and their material aspects. The experiential or non-material aspect is termed the emotion, while the material or physiological aspect is the expression of that emotion. As a consequence of this usage of terms, and of the acceptance of the prevalent doctrine as to the relation of consciousness to afferent and efferent nervous impulses, James was forced to the paradoxical conclusion that the emotion is not the cause but the result of its expression.

Our view agrees with that of James in maintaining that the terms emotion and expression must refer to distinctions within the total series of organic activities, and that these processes are peripheral and sensory in character. We

shall, however, adopt a radically different mode of division from that employed by James.

These organic activities may first be divided into three sets of psychophysical processes—the act, the emotion, and incidental by-products of the emotion. In anger, the term act is applied to those activities immediately concerned in combat —the fighting activities. Flight or running away is the act in fear. The term emotion refers to all those prior and accompanying organic processes whose function it is to render the act more efficient. The emotion and the act are to some extent independent variables; theoretically one can fight without being mad, and one can become angry without fighting. Likewise one can run away without being afraid, and fear without indulging in flight. The nature of the emotion and its functional relation to the act have been well depicted by Cannon. In general the emotion consists of those processes by means of which the total energy of the organism is mobilized and concentrated for the service of the act. The function of anger is to increase the efficiency of the fighting activities. A cause and effect relation obtains between the emotion and the act. The increased efficiency and sometimes the initiation of the act are thus a result of the emotion. The total series of processes involved in the organic disturbance may also contain other components which are to be regarded as the incidental but necessary by-products of the emotion or the act, but which contribute in no way to the efficiency of either. The trembling of anger or certain digestive and nutritive disturbances incident to the vasomotor shift may be adduced as hypothetical examples.

These three groups of activities—the act, the emotion, and their by-products—constitute the whole of the organic processes. There is no fourth class which can be termed the act of expression. The term expression implies a dichotomy of the same organic activities from another standpoint, viz., their relation to some observer. An emotion can express itself only by producing some effect upon an observer. Without an observer the term expression is without meaning.

The emotion can express or manifest itself to an observer

in three ways: (*a*) It expresses itself indirectly through its observable effects upon the act. Such characteristics as the determination, vigor, and persistence of the fighting act are observed and become the sign and symbol of the emotion of anger which produced them. The increased efficiency of the act thus constitutes both a result and an expression of the emotion. (*b*) Any of the observable by-products of the emotional situation also constitute a mode of expression. To an observer they may symbolize the existence of the inner emotional disturbance of which they are a result. (*c*) The emotion also manifests itself to an observer in a more direct fashion. Certain essential components of the emotional processes, such as the flushed face, the frown, and the deeper breathing in anger, are directly observed and constitute another mode of expression. The emotional process as a whole is not observed; only certain surface aspects of the total process are perceived. These perceived aspects are interpreted by an observer in terms of his experience and knowledge and hence become the visible symbols or manifestations of the emotion as a whole. A part thus becomes the symbol of the whole, and a symbol is a mode of expression. Good usage, I think, will justify this meaning of the term. We may thus legitimately assert that the emotional activity manifests or expresses its nature to an observer by means of these surface or observable features.

Our conception may now be compared with that of James. Both are actuated by the same purpose. Both attempt an expository definition of the popular meaning of two terms. Both attempt a definition of emotion and expression in descriptive and empirical terms. Both agree that emotion and expression must refer to certain aspects of the organic activities involved in the emotional situation. The two views ascribe radically different contents to these terms. James's analysis was dominated by the subjective conception of the province of psychology which prevailed at that time. An emotion as a psychological phenomenon must be defined in purely conscious terms; the physiological aspect of the process must be discarded. This subjective emotional experience

can naturally express itself to an observer only through behavior or physical means; the behavior, material, or physiological aspect of the process must then constitute the only avenue of expression. With this conception, emotion and expression must refer to the psychic and the physical aspects respectively of the organic reaction to the emotional stimulus, and in virtue of these definitions the emotion must be a result and not a causal antecedent of its expression. Our hypothesis rejects the purely subjective point of view in psychology, and consequently discards this psychophysical dichotomy of James. Both emotion and expression are regarded as psychophysical processes, or rather they are regarded as real functional activities of a human organism irrespective of the fact whether they do or do not contain a conscious component. According to our analysis, these terms have been so defined in relation to each other that one can say that the expression is a result of the emotion.

James's theory of emotion contains two more or less distinct doctrines whose validity must be separately estimated. One of these, to my mind, is correct, and the other fallacious. The first doctrine asserts that the term emotion refers to certain aspects of the organic activities and that these activities are essentially sensory in character. We have subscribed to this feature of the theory, and we believe that it constituted a genuine and important contribution to the psychological thought of the time. This aspect of the theory, it is well to note, is open to empirical verification; James's various factual proofs and the recent experimental attempts at a disproof are relevant to this aspect of the Jamesian doctrine. Needless to say, we believe that the factual evidence at the present confirms James's contention.

The second aspect of James's doctrine consists of the following features: (1) the assumption that emotion and expression refer to the psychic and the physiological components respectively, (2) the acceptance of the prevalent assumption as to the relation of the psychic to its physiological correlates, and (3) the final conclusion that the emotion is the result of its expression.

It must be at once admitted that this conclusion is *logically valid and unassailable* from the standpoint of the prior assumptions. Neither is the proposition susceptible to experimental proof or disproof. James's formidable list of factual proofs is not relevant to this phase of the argument. His conclusion is logically implicit in his assumptions; it represents merely the result of a deductive analysis of what was contained in his premises. James assumed the truth of this conclusion when he made his preliminary definitions. A rejection of one of these assumptions constitutes the only avenue of escape for those who dislike the final conclusion.

This aspect of James's theory contains, to my mind, two essential defects. (1) The conclusion contradicts common sense, and this contradiction is due to the fact that James ascribes to the term 'expression' a meaning which is directly antagonistic to the significance usually attached to it. As previously noted, the term expression popularly signifies some effect of the emotion upon an observer, and James has arbitrarily so defined the term as to reverse this causal relation. (2) James's analysis and conclusion are also lacking in pragmatic value. His mode of treatment gives us no analytical comprehension of the functional interrelations between the various constituents of the organic activities, nor of their nature and significance in relation to mental life and conduct. The conclusion resulting from James's mode of analysis is logically true and valid, but the knowledge it represents lacks genuine significance and worth.

In spite of varied criticism, James's theory has enjoyed an enviable reputation for many years. Several factors have probably contributed to this result. (1) Unless the two phases of the argument are differentiated, one is compelled either to adopt or reject the theory *in toto*, and undoubtedly to many minds the advantages of the theory outweigh its deficiencies. (2) As we have noted, James was driven to his psychophysical distinction by the adoption of the subjective conception of the province of psychology. Likewise, James's theory will of necessity make a strong appeal to those whose thought is dominated by this attitude of mind, and the

conventional definitions of the subject matter of psychology have, until recent years at least, been couched in subjective terms. If emotion is a psychological phenomenon, it must be defined in conscious terms. Expression, on the other hand, must be conceived in behavioristic or physiological terms, because expression must refer to some effect upon an observer. (3) The *paradoxical* character of the conclusion is a third factor. The popular mind is somewhat prone to judge the value and worth of a science upon the basis of the novelty and startling character of its discoveries. The wonders of a science are paraded in proof of its amazing progress in attaining its ends. These discoveries are frequently wonderful and startling simply because of their novelty and unexpectedness, —because they contradict or modify prevailing conceptions and opinions. Psychology as a young and growing science must also produce its miracles in order to secure popular acclaim to its worth and greatness, and what can be more wonderful and miraculous than the discovery and labored empirical demonstration of a truth which directly contradicts the common sense opinion of mankind? As psychologists, I fear, we have been somewhat susceptible to this influence, and this suggestible attitude of mind has probably been strengthened to some extent by our experience in the classroom. I know of no doctrine in psychology which is comparable with that of James's theory of emotion from the standpoint of inculcating in the mind of the average undergraduate a wholesome awe and respect for the achievements of our science. This chapter of James almost invariably makes a profound impression upon the student mind, and the reason is not far to seek, for it consists of a very clever and brilliant exposition, and a persuasive logical and empirical demonstration of the truth of a proposition which many students accept with some degree of mental reservation.

In place of James's psychophysical analysis, this paper suggests a threefold division of the organic activities on the basis of their *causal interrelations*. The act refers to those processes of adaptation to the objective situation. The emotion refers to those activities which increase the effective-

ness of the act. The remaining processes consist of incidental by-products of the emotion or the act. There is no coördinate fourth group of processes which can be termed the expressive activities. The term expression implies a dichotomy of these same activities from a different standpoint—their relation to an observer. The larger and more important portion of the emotional group of processes can not be directly observed; their nature and existence must be inferred from those aspects of the organic activities which are susceptible to immediate observation. Certain aspects of all three of the previously enumerated classes constitute a sign or symbol of the existence of these hidden operations, and consequently become the means by which these latter manifest or express themselves to an observer.

THE THEORY OF THE SOCIAL FORCES

BY H. G. KENAGY
University of Minnesota

It has been said that "the corner stone of sociology must be a sound doctrine of the social forces."[1] With certain limitations this statement may be allowed to stand. In the first place, pure science, as such, does not admit of the use of the term 'force' in the sense of the sufficient cause of any phenomena, physical or social.[2] Taken to mean, however, only an active factor in a given situation, 'force' is in common usage in the physical sciences and has been borrowed by the social sciences for want of a better term. At best it is only a helpful analogy. In the second place, a 'sound doctrine' of the social forces must not be taken to mean or imply an 'exhaustive, logical or psychological classification' of the factors active in social life (as has generally been done by the older sociologists), for the progress of scientific knowledge of human society is not dependent upon success in any such classification. Indeed, as Dr. Bernard has pointed out, "the most accurate possible classifications [of social forces] mark only the most elementary stage in the analysis of social phenomena."[3] Professor Ross's statement, therefore, interpreted or limited in these respects, comes to mean simply that an understanding of what are the active factors in social life is necessarily basic in any scientific study or discussion of social situations and institutions.

What are the active factors in social life? Some sociologists would limit them to forces which are social in their origin; others would include all factors, whatever their origin, which are socializing in their effects. Professor Baldwin

[1] Ross, E. A., 'Foundations of Sociology,' p. 181.

[2] See article by Prof. E. C. Hayes, 'The Social Forces Error,' in *Amer. J. of Soc.*, 16, 613–625.

[3] Bernard, L. L., 'The Transition to an Objective Standard of Social Control,' p. 74.

limits his definition to 'only those psychical products, called desires, which influence individuals in their social relations';[1] Professor Ellwood, much more sanely, uses the term to include 'every factor which has some degree of active influence in shaping and molding the forms of association and the interaction of individuals.'[2] Accepting this latter definition, as the more adequate of the two, we are forced to include among the social forces such physical factors as climate, soil, and other geographical conditions. To primitive men these environmental conditions were much more important than they are today, for civilized man has brought his environment largely under his control.[3] Heredity and variation must also be included as active factors. True, they are not direct factors, and, assuming a strict psychological interpretation of society, they become factors in the organization of society only by setting up conditions or limits within which, and only within which, the more strictly social forces may act.[4] At any one moment, perhaps, the forms of social life seem to depend much more upon mental elements than upon physical factors, but when one surveys human groups over long periods of time the influence of physical factors is more apparent. The environment has acted indirectly, selectively, upon man's hereditary equipment, but also directly, through such agencies as temperature for example, to modify instinctive and habitual responses of masses of individuals and the interaction between individuals.

Coming now specifically to a discussion of the psychological factors or forces in association, we may agree at once with Dr. Ellwood that these consist of man's innate impulses (instincts), his feeling states, and his cognitive or intellectual processes.[5] This assumes, apparently, the existence of a

[1] Baldwin, J. M., 'Social and Ethical Interpretations,' p. 484.

[2] Ellwood, C. A., 'Sociology in its Psychological Aspects,' p. 278.

[3] Thomas, W. I., 'Social Origins,' pp. 130 ff.

[4] See Baldwin, *op. cit.*, Appendix H v, p. 573.

[5] *Op. cit.*, p. 282. The feelings and intellectual processes may enter, however, only in their physical aspects as attitudes called out by stimuli and thereby influencing other responses in the same individual and in others. They cannot function in this connection purely as feelings and as awareness. We can know of psychic states in others only by the behavior of those individuals. These facts will be borne out later.

'social mind' and therefore 'social feeling' and 'social thought' which have the same functional relationship to social activity which individual feeling and thought have to individual activity—since social activity is due simply to the interaction and coördination of individual activities. Necessarily, therefore, we must decide first what is the functional relation of feeling and thought to individual activity. First of all, however, we must assign to instinct its proper rôle in determining activity.[1] Here there is more or less agreement. The instincts are of first importance because they are primary in man and serve in the initiation of action. Human conduct can never exceed the limits of these native proclivities which assign for man the ends of action and alone make any action worth while.[2] Man's native dispositions to activity, however, do not remain long unmodified, but, through interaction with the environment and by training, become overlaid with a mass of habits which come to function, under proper stimulation, as readily and as actively as did the original propensities to activity.

The moot point of the whole theory of social forces enters, however, at this point of the discussion. The issue centers around the part which feeling plays in determining the direction and extent of the modification of man's instinctive impulses to activity. The older view, held by the hedonists from the time of Hobbes to the present, assigns to feeling the function of a primary force, as lying behind these instinctive activities. All action, individual and social, was explained on a basis of pleasure and pain, as the springs of activity were to be found in calculations of agreeable or disagreeable sensations.[3] The late Professor Ward, the father of Ameri-

[1] By instinct is meant the inherited disposition to respond in certain ways when appropriately stimulated. This definition is used so that instinct may be taken as synonymous with the whole "original nature of man," and, for the purpose in hand, is sufficiently exact.

[2] See Veblen, T. B., 'The Instinct of Workmanship,' Introduction.

[3] See Hobbes, 'Leviathan,' Works, III., p. 42; Locke, 'Essay Concerning Human Understanding,' Book II., Ch. XXI., Sec. 33, 41; Bentham, 'Principles of Morals and Legislation,' Chap. I., Sec. I.; Spencer, 'Principles of Psychology,' II., p. 541; Baldwin, 'Handbook of Psychology,' pp. 301–303; Angell, 'Psychology,' p. 273; Patten, 'Theory of the Social Forces,' Chap. I., Sec. I.; Ward, 'Psychic Factors in Civilization,' pp. 52, 54, 126, and 'Pure Sociology,' p. 132.

can sociology, was particularly at fault in this regard. To quote short passages from his works: "The dynamic agent consists wholly of feeling;"[1] "Feeling is a true cosmic force . . . and constitutes the propelling agent in man and animals."[2] "In the associated state of men, it (feeling) is the true social force."[3] "The thinking faculty is not a force; but feeling is a true force and its various manifestations constitute the social forces."[4] True, Ward speaks of the desires also as a true social force, but he uses 'desire' in the 'feeling' sense,[5] saying that desire is a form of pain.

There are two other types of writers, only partially or not at all hedonistic, but individualistic for the most part, who treat of social forces as causes of activity in one way or another. One class regards feeling as one, but only one, of the determining factors in activity. Those of the other type hold that feeling can never be such a cause.[6]

What then is the actual part which feeling plays in initiating activity? The answer must first of all settle the question of what part consciousness plays, if any, in the process. The better psychology at present holds that mental processes are conditioned by changes within the organism, notably within the nervous system.[7] The more immediate physical qualities of mind lie within the brain and are determined (1) by stimulus and (2) by disposition or tendency, which latter indicates that the "neural functions are determined by the residues of earlier function (impressional, associative, determining and habitual tendencies, and general cortical set)."[8] The facts of perception are mainly to be

[1] 'Pure Sociology,' p. 256.

[2] *Ibid.*, p. 39.

[3] *Ibid.*, p. 99.

[4] *Ibid.*, p. 101.

[5] 'Psychic Factors in Civilization,' pp. 53–54.

[6] Among writers of the first class are Titchener (see his 'Outlines of Psychology,' p. 250), Thorndike (see his 'Elements of Psychology,' p. 284). Among writers of the second type are James (see his 'Psychology,' II., pp. 559, 580), Dewey (see Dewey and Tufts, 'Ethics,' p. 270), McDougall (see his 'Introduction to Social Psychology,' p. 43).

[7] Bentley, Madison, 'A Preface to Social Psychology,' in one of a series of articles entitled 'Studies in Social Psychology,' in PSYCHOL. MONOG. No. 92, June, 1916, pp. 10 ff.

[8] *Ibid.*, p. 10.

explained by stimulus and associative tendency; passive memory and imagination by associative and impressional tendencies; emotion and action by stimulus and determining tendency; skillful performance by habitual tendency; and thought by dispositions of the determining sort. In view of these facts we cannot admit that imagery is necessary, in any causal way, even to voluntary activity. Neither can we regard it as a superfluous or parallel process. Rather, imagery is the evidence of associations and neural activity between stimulus and response. It is these processes self-aware in a fashion. The complete determinant of voluntary activity is nothing more or less than the total set of the nervous system of the moment, plus the stimuli. The total cause of any act is certainly more than the conscious part of it. A percept or image, coming about when the neural pathway or the act is forced by interference to run probably through the more complex channels in the cortex, is not the cause of the act but only the sign of the whole act of which it is a part.

The same is true of feeling—it is not the cause of the act but only the sign of the whole act of which it is a part. Says Dr. Bernard: "Feeling modes are resultants of internal neural adjustments, . . . which correlation probably is made in the cortex only when feeling is experienced. It is absurd to speak of these feeling modes as the cause of such neural correlations."[1] Again: "Feeling . . . is the result of the correlation, that is, the supplementation or interference, of nervous processes in such a way as to increase the neural activity along a . . . given pathway. Where a nervous process is augmented, pleasantness is experienced, and where a nervous process is weakened or diminished, there is unpleasantness."[2]

Professor Ellwood professes to be in sympathy with these views as being simply more exact statements than the crude evolutionary view of feeling which he advances, and recon-

[1] *Op. cit.*, p. 37.

[2] *Ibid.*, p. 18. This theory is only a more accurate statement of the theory of feeling given by Max Meyer in his articles on 'The Nervous Correlate of Pleasantness and Unpleasantness,' in PSYCHOL. REV., 1908, 15.

cilable with it.[1] Feeling to him is however 'an organic valuation of our activities.'[2] He says: "Society is made up of biological and psychological individuals, and these individuals are thinking, feeling men whose actions are mediated, guided and *controlled* by feelings and ideas."[3] Again: "Feelings and ideas are not coëxtensive with activity," but 'relatively new and independent elements' which 'appear within physiological activities at certain points to evaluate them, mediate and control them.'[4] Finally: ". . . social phenomena are in the nature of responses to stimuli, and these responses are modified, in the mature individual at least, by complex series of feelings and ideas."[5]

To such statements must be raised the fundamental objection that they do not in any tangible way explain how feeling operates to accomplish its evaluating function. Why, for example, does the pleasurable act survive over the other acts? Can a successful result act backwards and strengthen the impulses leading up to it and stamp out the unsuccessful impulses? Hardly. Rather, it happens that "by the actual overlapping of many tendencies to respond in diverse ways the erroneous tendencies are directed into the successful ones and the latter are strengthened by reinforcement. Without such overlapping of various impulses in the same general response, the inhibiting effects of the successful upon the unsuccessful or irrelevant tendencies are incomprehensible."[6] The pleasure accompanying the successful act as a complete response is not itself a cause or natural antecedent of the surviving act but only the inner or 'felt' aspect of it and therefore valueless in explanation. The selectiveness of the organism, which Ellwood would call 'feeling control,' is simply its more easy adaptation to certain direct and indirect stimuli than to others, due to inherited and acquired nervous correlations. The pleasurable tone accompanying certain

[1] *Op. cit.*, footnote on pp. 112–13.
[2] *Op. cit.*, Chapter X., p. 247.
[3] *Op. cit.*, p. 250.
[4] *Op. cit.*, p. 250.
[5] *Ibid.*, p. 251.
[6] Peterson, J., 'Completeness of Response as an Explanation Principle in Learning,' PSYCHOL. REV., 1916, 23, 153–162.

activities is only a subjective indication that the response, up to a certain limit, follows the line of least resistance. Certain acts are 'chosen,' because they are on the whole the most natural to the organism under the circumstances, not because they are pleasant. That they *are* pleasant, in the main, indicates subjectively that the response is relatively 'complete' and in harmony with one's inherited and acquired organization.

As has been shown experimentally, some acts may be both pleasureable and painful, painful alone, or without conscious results. We may, again, experience pleasantness from higher sensory or ideational processes at the same time with pains from lower neural processes. Finally, any act may be made pleasant or unpleasant through habit. Consequently feeling modes cannot be effective guides to individual or social adjustment and control. Ideas, images or other subjectivistic criteria are not always valid, says Bernard, and are only dependable when checked up by objective reference. "Feeling," he states, "as the conscious part of mere correlation, *i. e.*, supplementation and interference of neural processes, is the least able to be so checked up and is consequently the least reliable of all subjective criteria or evaluations of action in an objective and social world."[1] Feeling is a purely personal and individualistic phenomenon.

A similar problem to that of determining the function of feeling in connection with the forms of association and individual interactions is presented in establishing the rôle which the intellect or the cognitive elements of mind play in these processes. Professor Ellwood holds that "the distinctive character of our social life is due to the modifying influence of intellectual elements,"[2] and he maintains that the intellect plays a decisive rôle not only in adapting the individual organism, in man at least, to his environment, but also in bringing about those 'higher adaptations which characterize civilized societies.'[3] Again, he says that the intellect, the

[1] *Op. cit.*, p. 28. Practically the same view is set forth by Dr. A. F. Bentley. See his 'The Process of Government,' Chapters I. and II.

[2] *Op. cit.*, p. 261.

[3] *Op. cit.*, p. 261.

cognitive, objective side of mind, 'evaluates activities with reference to the environment and functions to mediate and control them with reference to environmental factors."[1] And finally: "While the intellect seems to have been developed chiefly as an aid in carrying out the instincts and in satisfying the demands of feeling, in its higher reaches it can and does *act more or less independently* of them."[2] By this last statement he means that the intellect modifies instincts, substituting habits for them which become as strong as the original instincts.[3]

Such passages seem, almost, to set up the human mind as a separate, supernatural entity which acts as a sort of dictator to instinct and feeling and to motor responses. This idea is brought out more forcibly when he says that "more and more the process of living together needs the interference of reason."[4] What Professor Ellwood means, however, seems to be only that ideas have come largely to be the stimuli to activity among civilized peoples. Reflective thought, which played an insignificant rôle in primitive society, is now, he thinks, the decisive element because "upon it depends the control, not only of the forces of physical nature but also, . . . of the feelings and impulses of human nature."[5] For this reason, and in this sense, he argues that ideas are entitled to be called forces, "since they at any rate become active factors in the later stages of social evolution and absolutely decisive, . . . in the making of the more complex adjustments."[6] These ideas, in civilized man at least, come in time to constitute for the individual and society a sort of 'subjective environment' and to this environment "the mass of individuals respond quite as they do to stimuli in the objective environment."[7] Professor

[1] *Op. cit.*, p. 263.

[2] *Op. cit.*, p. 263.

[3] Practically the same view of the function of the intellect was held by Ward. See 'Pure Sociology,' Chapter XVI.

[4] *Op. cit.*, p. 264.

[5] *Op. cit.*, p. 264.

[6] *Ibid.*, p. 277.

[7] *Ibid.*, p. 265. The same position is argued at length in his recent article: 'Objectivism in Sociology,' in the *Amer. J. of Soc.*, December, 1916.

Ross goes farther. Thus he says: "The key to his behavior (civilized man's) lies no longer in the play of stimuli upon him, but in his consciousness. This has gathered in volume and consistency until his center of gravity lies here rather than in current impressions. The mental content has acquired such mass, and experience has been wrought up into such forms—idea, concept, formula, ideal—that at each moment they control more than do the external conditions."[1]

As was said above, such statements seem to make of the mind a metaphysical entity with independent control over man's activity, though all the writers mentioned would deny such an intention or belief strenuously. However, there remains the further great objection that such statements do not account for human individual and social activity or tell how the intellect accomplishes its wonderful work of adjustment. We look in vain also for any hint of what may be meant by 'intellect.' Perhaps it is not the duty of the sociologists, as such, to carry their discussions back into basic psychological and neurological terms, though professed social psychologists should not shrink from it, but it would seem that a 'sound doctrine' of social forces must be built upon a deeper analysis of the conditions of activity than is indicated by 'impulses,' 'feeling states' and 'ideas.'

For the sociologists or psychologists who are interested solely in behavior, the 'intellect' can only be the sum total of neural correlations or nervous associations set up in the higher brain centers by the experiences—stimuli and responses—which have constituted the life of each individual. An 'idea' is itself in every case the product of sensory stimulation and can only be in terms of past experience. It is a felt association and tendency to response, based on neural correlation, effected by some vicarious stimulus, *e. g.*, a word seen or heard which has been associated previously with the particular act. As such, it cannot be the cause of an act. A stimulus is a physical agent, acting upon a receptor-organ and initiating there a series of concrete organic processes.

[1] 'Foundations of Sociology,' p. 159. The same notion of the idea as the actual or immediate cause of an act is held by James (see his 'Psychology,' II., pp. 559, 580), and by Dewey (see Dewey and Tufts, 'Ethics,' p. 270).

'Ideas' or 'images' cannot be called stimuli in this sense when used to account for the fact that a man kills his neighbor or destroys his property, or when given as the cause of the acts of a college professor. Until empirically defined these terms are sheer 'ghosts' used as agents or forces. As was said above, in speaking of the part which consciousness plays in activity, the idea is only the sign of the whole act of which it is a part. To quote Dr. Bernard again: "When an idea or image precedes an act, *i. e.*, when the neural pathway or the act runs through the cortex (as it must when there is considerable conflict and impediment to its overt expression), the act is termed voluntary. Because we are not able to determine the total set of the nervous system, we seize upon its most obvious and immediate sign, the percept or image (the idea) and call it the cause, ... If the process of ideation be a long one, *i. e.*, if the process by which an act finally gets overt expression is modified by a great many inhibitions occupying some appreciable length of time, we term the subjective process *thinking*, and we speak of thought as the cause of our activity, while it is only the sign or index of the whole act of which it is only a part."[1]

What is true for the activity of the individual is true also for the whole social group. As an appeal to the physical concept of 'force' to account for the facts of social interaction must be regarded as crude and unpsychological, so we must object to the subtler and more common approach through 'social consciousness,' which is widely accepted as the condition primarily involved in human relations. There is no demonstrable class of mental functions which can properly be designated 'social,' just as there are no 'social' conditions of consciousness to be added to stimulus and disposition. "It is not consciousness that is social; objects and events are social."[2] Consciousness in the group is conditioned just as other consciousness is. The conditions of group relations and of their functions must be concrete empirical conditions and not abstract social faculties such as 'social consciousness,' 'group spirit,' or 'collective reasoning.'

[1] Bernard, *op. cit.*, pp. 36–7.

[2] Bentley, Madison, *op. cit.*, p. 13. They are social because they stimulate and develop common habits and therefore common mental processes in many individuals.

If the mind is conditioned, as was shown above (p. 5), by stimulus and disposition or tendency, the use of such expressions in connection with social activity as: "mind 'influenced' by another mind," "Man is 'suggestible' or 'imitative,'" "one mind 'rules' or 'dominates' and another 'acquiesces,'" etc., is wholly outside the plane of scientific explanation. A stimulus, as said before, is a physical agent and sets up a series of concrete organic processes. 'Suggestion,' 'imitation' cannot be accounted such agents when used to explain the destructive activities of a mob, nor can 'domination' or 'sense of power' be given as the cause of the acts of a railway trainmen's union. Used in such a fashion such terms are wild abstractions used as forces,[1] and are closely akin to the 'faculties' of two centuries back.

'Faculties,' of course, is unacceptable for the purposes of scientific explanation, but we also lack a concrete meaning for 'mental dependence' or 'mental interaction' in such a statement as "individuals tend to believe and to think and to feel, etc., in mutual dependence." "It is obvious," says Bentley, "that the mind of my neighbor is not to be added, as a condition of my mental processes, to the sober and authenticated facts of stimulus and disposition. If my neighbor speaks with the voice of authority and decision and so convinces me that I should attend the meeting of the Municipal League, my mental processes are set up, after all, just as they would be if I found a blight upon my fruit trees and decided to destroy the orchard. Auditory or visual stimuli and associative tendencies account for the perceptual part of either experience, and determining and habitual tendencies for the performance.

"The only thing that is unique about the conditioning factors in social or mental dependence is the fact that the presence of other persons . . . or the assumption of them . . . touches off certain dispositions or neural tendencies, giving to our 'social experiences' a certain kind of significance. The sight of the blighted fruit trees and the sight and sound of my persuasive neighbor are psychological

[1] Illustrations of this are to be found in Ellwood, *op. cit.*, pp. 283 ff., 288; Ward, 'Pure Sociology,' pp. 256 ff., 457 ff.; Ross, 'Social Psychology,' p. 13.

events of the same order. There is not, in the one instance, the mere apprehension of an object; in the other, the operation of a subtle and mysterious force through the agency of which my mind is wrought upon by my neighbor's. Because of my constitution and my history the two things are differently apprehended, have different significance, and lead to unlike performances."[1]

Classifications of the social forces have been attempted by sociologists from Hobbes, Fourier and Spencer to many present-day writers, and the majority unite in placing emphasis upon the psychic factors or forces, though the later writers reject the old hedonistic criteria and adopt the functional view. However, with only one important exception,[2] all classifications have been subjective in that the content is lodged in the individual consciousness as the source of activities. What is needed is a classification of social forces which does not stop with consciousness, real or imaginary, and, in so doing, cover up the real and objective sources of stimulation to activity.

The most complete, accurate, and objective classifications of the social forces must constantly aim to point out, according to Bernard, (1) how the individual acts or behaves, the organs he uses and how he uses them when stimulated in known or unknown ways, and (2) how a group acts or behaves, the types of control which are exercised over individual activities or behaviors, in known or unknown ways. In the individual these may be instinctive or acquired (habitual) tendencies; in the group they may have grown up unconsciously through custom, or they may have been consciously legislated into existence, or taken on through the pressure of public opinion, or as a result of scientific investigation.[3] The 'causes' of activity under (1) have been called 'social

[1] Bentley, *op. cit.*, pp. 11–12.

[2] Recently a very valuable and suggestive inventory or classification of the responses of the original tendencies in man to various classes or types of stimuli has been made by Professor E. L. Thorndike in 'The Original Nature of Man,' 1914. He regards this, however, as only a beginning—as indicating the direction which further inquiry must take and the subject-matter with which truly objective classifications will have to deal.

[3] See his discussion, *op. cit.*, p. 73 ff.

forces' and the subjectivists have traced them back to the individual consciousness and lodged them there, 'because the individual is usually conscious of his socially most conspicuous acts, and when he is not thus conscious, consciousness is . . . assumed.'[1] Thus the early sociologists stopped at the sacred threshold of consciousness and ended their search for social forces in the *forms* of consciousness. Only recently has psychology pointed out that consciousness is not ultimate, but is caused, and is only *one* factor in adjustment. The social behaviors under (2) have also, by analogy, and with the same subjective emphasis, been called 'social forces,' being abstracted for this purpose from the unified social situation and made the product of individual activity. The distinction was not made, between 'interests' and 'desires,' nor was it recognized that the latter type of behaviors is to be termed 'social forces' with more reason than the former, since they necessarily go behind the individual consciousness to some extent.

The passage from an introspective to an experimental and biological psychology, with its analysis of the conditions of consciousness and its functional activities in making adjustments to the environment, has caused us—forced us—to look back of the mere forms of consciousness in studying social causation. Our search for 'social forces' must undertake to account objectively for the activities of the individual and of the social group. In actual practice we have adopted this method. Thus, for example, we have 'ceased treating disease on a demonistic basis, or attempting to cure national ills by public prayer.' We still, however, practice retaliatory methods in our criminological procedures, and limit morality in general to the scope of consciousness or intention.[2]

The old classificationists present the subjective social forces as only forms of consciousness by which the conscious person is made aware of his own activities, while their formulations of objective social forces are only abstractions for presenting to ourselves the social processes. Says Bernard,

[1] *Ibid.*, p. 74.

[2] For a critical discussion of this point see Bernard, *op. cit.*, Introduction.

in speaking of these abstractions: "They are not forces; at the most they are partial indices of social 'forces' or processes. Nor have they constant equivalents; for conscious processes and our statements of social processes have at different times different activity equivalents. . . . They are qualitative rather than quantitative indices. They merely invite to always further analysis and re-analysis of the objective social situation; and it is on the bases of these analyses that all our problems are to be comprehended and effectively solved. When a situation is once adequately analyzed, when the forces lying back of the forms of consciousness or the abstracted and generalized types of social and individual activity are understood, the method of the solution of the problem is simply that of the application of common sense. The only mystery that there is about the treatment of social problems is that which we make by being content to stop with the forms of consciousness in our analysis. We talk about the riddle of personality as an impregnable barrier to an adequate understanding of social conditions, because we are attempting to work out a logic of forces and activities from the kaleidoscopic presentations of our conscious processes."[1]

The problem ahead of the sociologists, then, according to Bernard, "is to push farther back the analysis of objective phenomena." Until sociology abandons its subjective criteria it cannot attain to true scientific efficiency. "As psychology retreats from its introspective analysis of the solipsistic self, and as ethics gives up mere intention as the criterion of morality, so sociology must turn from a subjective classification of 'social forces' and study the functioning of objective social processes as they operate in individuals and groups."[2]

Summary

Sociology, ethics, and the other social sciences are in need of more tangible explanations of individual and social action than are commonly given, and they have a right to look to psychology for a true statement of the facts so that

[1] *Op. cit.*, pp. 75–6.

[2] *Ibid.*, p. 76.

all can work on the same plane. The terminology now in common use implies or postulates the possibility of stimulation by such subjective factors (frequently referred to as 'forces') as 'feelings' and 'ideas,' though the way in which they become stimuli has never been satisfactorily explained. This conception seems to have failed in the explanation of behavior as much as the 'faculties' now supposed to be discarded from psychology.

All tangible stimuli must be of such a nature as to set up nerve impulses. They may come from within or from without the individual. He may be stimulated by external things—by other persons, by spoken or written words of his language, by books, etc.,—or by organic processes and muscular changes within his own body. Organized stimulus-response systems as developed by habits are important in determining the direction and the extent of his responses. It is inconceivable, therefore, how conscious states can serve as stimuli; for all conscious states are but imperfect, subjective representations of stimuli in the objective world. The customary usage thus involves one in a vicious circle.

In group relations, therefore, explanations must hark back to stimulus, disposition, and response instead of halting upon the plane of 'mental interaction,' 'suggestion,' 'social consciousness' and the like. The uniform action of individuals in society is due to common sources of stimulation, to common associative tendencies, and to common habits, overlapping in the generations. Divergent reactions are due to differences in organic set or total nervous organization, which are the products of more or less unlike heredity and experiences. Finally, the 'intellect' can not be set up as a separate entity operating as a force or cause in inducing action or in mediating activity. As an aspect of the sum total of nervous correlations in the higher brain centers, the intellect can not be considered as a causative agent, nor can an idea, which is always the outcome, though remotely so, of sensory stimulation, be used as the cause of individual or group activity.

THE MENTAL WORK CURVE

BY DANIEL STARCH AND I. E. ASH

University of Wisconsin Ohio State University

Practically all studies in the field of mental work and fatigue have employed, in one form or another, one of two general methods of investigation. According to one method the subject is required to perform certain tests at the beginning and again at the close of a period of work, or at intervals during its progress. The differences between the successive applications of the tests are regarded as measures of the effect of the intervening work. According to the second method instead of making comparisons of the results of short tests at the beginning and at the end of the period of work, a study is made of the progress of the work itself, and the factors which affect its progress.

Instead of regarding these two methods as different ways of dealing with the same general problem, they should rather be regarded as two distinct problems, since they differ not only in procedure, but also in the result sought. The former tries to secure results that shall be free from the influence of such factors as practice, "warming up," and variation in attention and interest and to obtain an index of fatigue only as it is developed in the course of the work. The latter, instead of trying to eliminate the influence of these factors, tries to take particular account of them and to assign to each its specific value in the work curve.

It is very essential in studies of the latter type that the task done be of uniform difficulty throughout the entire period of work. Otherwise we shall not know whether the variations in the curve are due to conditions in the work or in the worker. It is likewise very desirable to employ a form of activity which involves a minimum of physical effort and sensory strain, so that the mental factors may be isolated as fully as possible. The kind of work which has proved most

satisfactory, and which has been most extensively used, is some form of mental computation.

The Experiments.—In a recent study of mental fatigue[1] results were secured from forty-five hours of mental calculation done under uniform experimental conditions and carefully checked both as to the number of errors made and the amount of work done in each successive half-minute. Twenty-three persons took part in the experiment. The work was done in forty-one periods varying in length from thirty minutes to two hours and a half. The type of work done was that devised by one of the writers and described elsewhere.[2] This method was essentially as follows:

The subject was seated comfortably in a quiet room. The experimenter began by giving him a number consisting of two digits. The subject added mentally, six to this number, then seven to the sum thus secured, then eight to this last sum, and then nine to this result, and then again six, seven, eight, and nine in rotation, adding in every case to the sum resulting from the previous addition. The subject spoke his answers aloud. At the end of thirty seconds the experimenter announced a new number and the subject immediately dropped the series on which he was working and began with this new number by adding six, seven, eight, and nine in rotation as before, for another thirty seconds when another starting number was given, and so on without interruption for the entire period of work. The advantages of this type of addition are that it reduces all physical and sensory elements to a minimum, that it taxes mental effort to its full extent, as was witnessed by every person who took part in the experiment, that it is almost perfectly continuous, giving no opportunity for relaxation, and that it is composed of small and fairly uniform units of work in terms of which the results can be measured accurately. Even adding columns on paper involves more muscular and sensory activity than the present type of addition involves. The subjects were usually allowed

[1] Ash, I. E., 'Fatigue and Its Effects upon Control,' *Archives of Psychology.* Vol. V., No. 31. The results here discussed were not presented in that monograph.

[2] Starch, D., 'Experiments in Educational Psychology,' pp. 172–181.

to make two or three practice series of the additions before the regular experiment was begun.

When the sum of successive additions had reached one hundred or more the hundreds digit was dropped and the additions continued with the units and tens digits. Thus, if the number first given was 72, then the successive sums should be 78, 85, 93, 102, 108, 115, etc., but instead of giving these last sums as 102, 108, 115, they were given simply as 2, 8, 15, etc.

To enable the experimenter to keep the results accurately mimeographed sheets of paper were prepared in advance which contained all the numbers used as starters[1] and, in columns directly under them, the correct sums of twenty additions. Whenever the subject gave an incorrect sum, the experimenter wrote it down beside the correct sum. A line was drawn under the sum resulting from the last addition in each thirty-second period, so that an exact record was kept of the amount and accuracy of the work done. During the experiments, the subjects either closed their eyes or sat in such a position as to be unable to see the experimenter in order to avoid distractions and to concentrate to the fullest extent upon the task of the experiment. Neither subject nor experimenter spoke a word during the experiment except the "starting numbers" which were given by the latter, and the results of the successive additions by the former. No time was allowed to elapse between series.

Results.—The data afforded by these experiments may be treated from several different angles, and will throw light on a number of important phases of the problem of mental work and fatigue. The first questions to suggest themselves very naturally related to the general form of the curve for work periods of varying lengths. How soon after beginning work does one reach his maximum efficiency, and how long will he be able to maintain it? How closely will the curve of work for one day represent that of another? How widely

[1] The numbers used as starters comprised all the numbers between 10 and 100 except those whose right-hand digit is 0 or which will produce sums whose right-hand digit is 0. All these were omitted since the additions in such cases are decidedly less difficult.

do different persons vary with respect to the form of their work curves? How greatly and in what general respects do the work curves of those who work slowly differ from the curves of others who work rapidly?

The results are shown graphically in Figs. 1 to 4. The points in the curves represent the average number of additions made in each five successive thirty-second series. The curves for the errors are shown in the lower part of each figure. Fig. 1 shows the composite curves for three two-hour records obtained from two subjects. Two records were obtained from one subject. Fig. 2 gives the results for nine one-and-a-half hour records obtained from eight subjects. Fig. 3 represents twenty-one one-hour records obtained from fourteen subjects. Fig. 4 represents eight half-hour records obtained from four subjects.

These figures show that the number of additions per unit of time gradually increases during the first twenty-five to thirty-five minutes, when the maximum speed is attained. This maximum speed is maintained for another thirty or thirty-five minutes, at which time the number of additions begins gradually to decrease and continues to do so until the work ceases. The curve of errors takes, on the whole, the opposite direction to that of the work curve. That is, the number of errors is the largest when the number of additions is the smallest. There is greater "zigzagging" or irregularity in the work curves when the rate of addition is highest. The initial period of increase in the rate of additions is not found in Fig. 1. That is, the rate at the beginning of the experiment is as high as at any time during its progress. This is probably due to the fact that the subjects were quite familiar with the work of the experiment since they had made shorter records before.

While the curves in Figs. 1 to 4 show clearly that there are fewer additions made in those periods in which the number of errors is greatest, they do not show the full difference in the number of additions made in those series in which errors occurred and those in which no errors occurred. In order to determine just how great this difference was, the

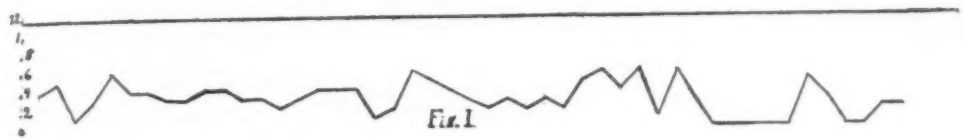

Fig. I.

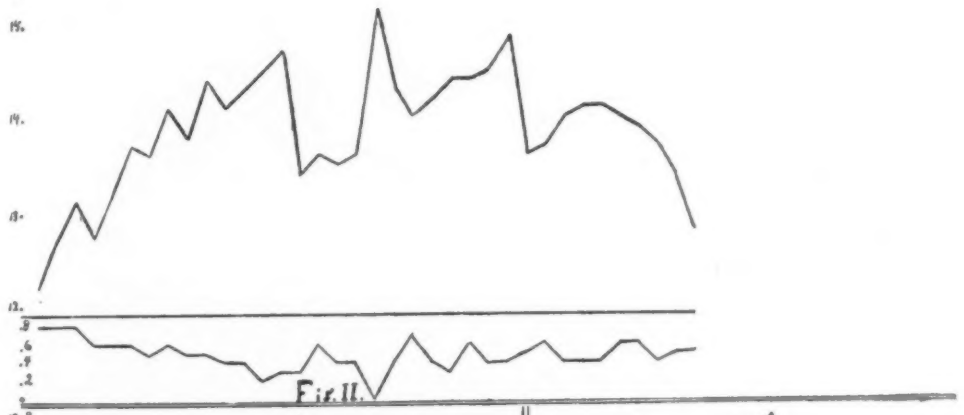

Fig. II.

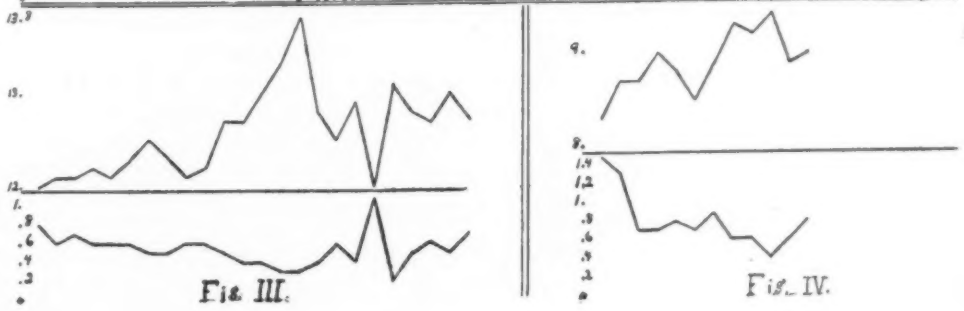

Fig. III.

Fig. IV.

number of additions in those series which contained errors, and in those which contained no errors was counted.

Before doing this, however, the data of all the experiments were divided into two groups. Group I. included those experiments in which the subjects averaged more than twelve additions in each half-minute period or series. Group II. included all those records in which the average was less than twelve. The experiments of Group I. covered 25 hours of work and therefore included 3,000 half-minute series of additions. In 2,333 of these series, no errors were made; while in the other 667 series 920 errors were made. The average number of additions per half-minute period in the series in which no errors were made was 17.2. The average for the 667 series in which errors were made was 11.8. In other words, an average of 46.2 per cent. more additions were made in those series in which no errors occurred than in those in which errors did occur.

The experiments of Group II. covered 20 hours of work and included 2,400 half-minute series of additions. In 1,441 of these series, no errors occurred. In the remaining 959 series, 1,784 errors occurred. In this group, the average number of additions per thirty-second period for the series which contained no errors was 9.71 and for those in which errors did occur the average was 7.8. In this group there were, on an average, only 23.8 per cent. more additions made in those series in which no errors occurred than in those in which errors occurred, as against 46.2 per cent. in Group I. These results indicate that those who worked rapidly worked more accurately than those who worked slowly. The more significant fact, however, brought out in these results is that it requires a longer time for any one, whether he work rapidly or slowly, to make an incorrect addition than a correct one. This fact, overlooked by many investigators, obscures the signs of fatigue, which have been sought by the method of continuous work. Fatigue is unquestionably developed in all such experiments but it is not shown in the actual output of work.

These figures, however, do not express the real, or full

differences between the number of correct additions made in any unit of time and the number of incorrect additions for the same time; or the effects which an error, or those factors which cause one to make an error, have upon one's speed in mental work. In order to show the full significance of the errors, or of the factors which caused them, in slowing up the work, a computation was made of the number of additions in those half-minute series which contained errors, before any errors were made, and also of the number including and following the first error in each of the different series. In all of the 667 series of Group I. which contained errors, the total number of additions before the errors occurred was 5,714. The total number of those including and following the errors for all the series was 2,177. We may reasonably assume that the rate for those additions which were made before any errors occurred would be the same as for those series which contained no errors. If this assumption be correct, then the amount of time required to make these 5,714 additions which were made before the errors took place would be about equal to 331 thirty-second periods, leaving 336 periods to make the 2,177 additions which included and came subsequent to the errors. This would make an average for these additions of 6.5 per thirty-second period, or slightly more than one third the rate when no errors occurred. In the 959 series of Group II. which contained errors, 3,846 additions were made before any errors occurred, while the number including and following the errors was 3,665. Treating these numbers as we did those in the preceding group we find the average rate for the incorrect additions and those subsequent to them in the series in which they occur to be 6.5 per thirty-second period, or about two thirds the rate for those series in which no errors occurred.

That the assumption is substantially correct is indicated by a special record made on one subject in which the exact time was noted when the first error in each series occurred. In this record the time per addition after the error occurred was 3.78 seconds, or 31 per cent. longer.

Still another factor in the distribution of errors and the

effect of this distribution on the rate of additions is the relative number of series containing errors at different stages in the experiment and the number of errors in each of these different series. This distribution is shown in the following tables. (Table I. giving the results of Group I.; Table II. those of Group II.) The top horizontal row gives the suc-

TABLE I

GROUP I

1...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2...	20	20	20	20	20	20	7	7	7	2	2	2	1	1	1
3...	400	400	400	400	400	40	140	140	140	40	40	40	20	20	20
4...	156	129	116	100	84	60	8	6	5	0	1	1	0	1	0
5...	159	129	127	129	124	115	40	36	39	0	6	6	0	7	0
6...	1.0+	1.0	1.1−	1.3	1.5−	1.9+	5.0	6.0	7.8	0.0	6.0	6.0	0.0	7.0	0.0
7...	39	32	29	25	21	15	5.7	4.3	3.6	0.0	2.5	2.5	0.0	5	0.0

TABLE II

GROUP II

1.....	1	2	3	4	5	6	7	8	9	10	11	12
2.....	21	21	21	13	13	13	5	5	5	1	1	1
3.....	420	420	420	260	260	260	100	100	100	20	20	20
4.....	202	176	170	106	105	110	34	33	17	3	1	2
5.....	342	324	347	165	168	194	61	73	60	11	8	11
6.....	1.7−	1.8+	2.0+	1.6−	1.6−	1.8−	1.8−	2.2+	3.5+	3.7−	8	5.5
7.....	48	42	40+	41−	40+	42−	34	33	17	15	5	10

cessive ten-minute work periods. The second row gives the number of records concerned in the experiment; the third row gives the total number of half-minute addition series made in the successive ten-minute periods; the fourth row gives the number of half-minute series in which error occurred; the fifth row gives the total number of errors; the sixth row gives the average number of errors in those series in which errors occurred; and the seventh row gives the percentage of series containing errors out of the total number of series made.

The reason why the numbers in the second row decrease from left to right is that not all records were of equal length. Twenty records in Group I. extended through the first six ten-minute periods, seven through the next three, etc.

It will be seen from the foregoing tables that not only does the number of errors decrease as the work proceeds, row 5, but more particularly does the number of the series which contain errors decrease, rows 4 and 7, while the number of errors in those series increases, row 6.

These facts very naturally raise the question: What causes these errors in the additions, and why should they become fewer as the work proceeds? It is clearly evident that these errors did not occur because the subjects did not know the sums of certain numbers to be added. The errors undoubtedly resulted from a kind of interruption. Some other thought, coming into the focus of consciousness, momentarily crowded out the number to be added, or the previous sum to which this number was to be added.

Now if we take mental fatigue to mean (as we have shown in the article previously referred to)[1] a loss of control over the direction which any particular nervous excitation within the brain shall take, and a growing inability to inhibit or repress irrelevant or obtruding ideas and suggestions, and analyze the work from that point of view, we may see how fatigue can be developing all the time during the work and yet the gross results show little or no effects of it. At the beginning of the work all one's faculties are alert and ready to respond to the slightest suggestions, or the intrusion of any idea or impression. But as the work proceeds the faculties become, as it were, insulated to extraneous suggestions and intruding impressions. While from two fifths to one half the series of additions at the beginning of the work contained errors, at the end of an hour and a half or two hours only about one twentieth to one sixth contained errors. At the beginning of the work we are required not only to make the additions but also to combat the host of intruding ideas which are striving for a place in the focus of consciousness. Every one who engages extensively in mental work, especially if it be varied in character, knows that a certain amount of time is required to "get settled" to any particular kind of work. We say we can not concentrate at

[1] 'Archives of Psychology,' No. 31.

the beginning of work, which is only another way of saying that we cannot successfully combat irrelevant ideas which are seeking to intrude themselves into consciousness.

To attempt to measure mental fatigue by such experiments as are usually employed in those studies which employ the methods of continuous work is like having the subject do a number of things at the same time and then measure his efforts by what he accomplishes in one of them. Such a method would not be very far wrong if the relative difficulty of the different activities remained constant throughout the work period. But if the unmeasured activities can be shown to grow constantly less difficult as the work progresses, then it is evident that more could be accomplished of that which is being measured without, on the whole, the expenditure of greater effort or more energy, or the same could be accomplished with the same expenditure of effort.

It has been shown in muscular work and fatigue that, as the muscles become fatigued, there is developed a resistance to motor impulses in the nerve tracts leading to the fatigued muscles. This resistance protects the muscles from complete exhaustion which would occur if every motor impulse reached the muscles without having any of its force or strength neutralized by this nervous resistance which arises as fatigue of the muscles develops. Just so in mental fatigue. As the mind becomes fatigued by mental work its "receptive" faculties become less responsive. Fewer impressions and suggestions enter the mind, and as a result fewer demands are made upon it as fatigue develops, and more of our mental energies can be devoted to dealing with those ideas and impressions which we are consciously and purposely introducing.

The question may have arisen: Why is it that there are fewer errors at the close of a period of work than at its beginning, if fatigue means the loss of control over the processes of mental associations and mental elaborations? Adding two numbers is simply making an association between two numbers to be added and a third which is their sum. The answer is that this loss of control affects first the most recent

and hence the least familiar forms of mental associations. In the matter of adding simple numbers the associations are old and well formed. The association is so completely formed that the stimulus of the former will naturally bring forth the response of the latter or the sum, unless that stimulus be confused by the presence of another idea or impression.

That these irrelevant thoughts and impressions are less easily controlled when the mind is fatigued, if they succeed in entering the focus of consciousness, is shown by the fact that near the end of our experiments, when an error did occur in an addition series, it was usually followed by four or five more. In other words, when the intruding impression got into the focus of consciousness and hence crowded out the numbers to be added, it required a longer time and more effort to suppress the former and recall the latter.

Summary

1. The number of additions per unit of time gradually increases during the first twenty-five to thirty-five minutes of work. This maximum is maintained for approximately thirty to thirty-five minutes. Then the number of additions gradually decreases until work ceases.

2. The curve representing the errors has in general the opposite course. The number of errors decreases as the speed of addition increases, and then increases again as the speed decreases. An incorrect addition occupies considerably more time than a correct addition does.

3. The half-minute periods in which errors occur becomes considerably less numerous during the progress of work even toward the end of long work periods, when the speed of adding again decreases.

4. But when an error does occur it is followed immediately by other errors more and more frequently as the period of work continues.

5. The explanation offered for this fact is that as work continues the mind and the neural processes involved become more and more insulated against distracting stimuli accompanied by a decrease in controlling the direction of mental

energy. The decrease in the occasion of errors would seem to indicate the former and the increase in the number of errors in immediate succession would seem to indicate the latter.

6. Slow workers make relatively more errors than rapid workers make. The difference is considerable.

7. In some respects the most striking fact brought out by these experiments is that mental work, even of a difficult nature, and when continued without interruption for as long as two and a half hours, seems to produce a much smaller lowering in speed or accuracy than is commonly supposed.

INDIVIDUAL DIFFERENCES IN A NORMAL SCHOOL CLASS

BY ROBERT A. CUMMINS

State Normal College, Bowling Green, Ohio

The data which form the basis of this article were obtained in connection with an advanced course in educational psychology given at the Bowling Green, Ohio, State Normal College during the summer session, 1916.

TABLE I

PHYSICAL DATA

No. Pupil	Age	Sex	Weight	Vital Capacity	Vital Index	Height Standing	Height Sitting	Relation
Ave....	.....	.....	60.8	3,600	59.2	165.6	87.7	52.3
1	28	M	59.0	4,700	80	178	93	52
2	30	F	57.7	3,600	62	163	89	54
3	39	M	75.5	4,800	64	169	93	55
4	32	M	70.5	4,800	65	172	88	51
5	25	F	52.5	3,000	57	153	83	54
6	28	F	45.2	3,000	66	159	82	52
7	31	F	52.7	2,600	50	161	83	52
8	28	F	59.5	3,400	58	161	88	54
9	19	F	69.6	3,800	55	171	89	52
10	29	F	56.7	3,200	56	171	93	54
11	35	F	62.2	3,100	50	156	84	47
12	25	M	63.0	3,900	63	170	90	52
13	31	F	66.0	2,900	44	169	87	51

No. Pupil	Head Girth	Head Length	Head Width	Cephalic Index	Grip R. H.	Grip L. H.	Relation	Strength Pull
Ave....	55.6	18.5	14.8	80.2	89	81.8	81.6	60.8
1	54.0	18.5	14.0	76	100	100	100	70
2	57.0	19.0	15.0	79	70	66	94	55
3	56.0	18.5	15.0	82	148	133	90	110
4	56.5	18.5	15.0	81	120	100	83	62
5	55.0	18.0	15.0	83	67	58	87	58
6	54.5	18.5	14.5	78	70	65	93	40
7	56.5	19.0	15.0	80	80	65	75	53
8	55.5	19.0	14.0	73	100	80	80	58
9	58.5	19.5	15.5	79	85	88	103	60
10	55.0	18.0	15.0	83	70	65	92	50
11	55.5	18.5	14.5	78	72	75	103	58
12	54.5	17.5	16.0	91	100	100	100	70
13	54.5	17.5	14.0	80	75	68	91	48

The great variation among the members of this class with respect to age, experience, physical inheritance, etc., offered an exceptional opportunity to illustrate some of the more essential facts of individual differences by the measurement of the class itself.

Then, too, it was desired to demonstrate to the class the value of the experimental method of teaching a subject like psychology.

TABLE II

PSYCHOLOGICAL DATA

No. Pupil	Log. Mem.	Rote Mem.	Digit-Symbol	Symbol-Digit	Free Asso.	Opposites	Add. O. I	Add. O. II	Add. O. III	Genus-Species
Ave.....	38.3	93.0	29.2	29.9	24.2	26.0	27.7	27.7	14	15.8
1	25	89	28	27	23	24	26	26	12	16
2	40	91	31	42	24	28	28	20	16	14
3	44	85	21	23	23	26	20	28	22	22
4	25	82	24	32	24	22	20	26	14	14
5	28	91	27	24	24	26	28	36	4	10
6	43	93	38	33	27	30	30	32	18	22
7	44	112	31	30	30	34	34	32	20	22
8	30	83	32	35	17	30	34	30	8	4
9	43	101	27	28	20	28	30	28	18	20
10	49	102	31	32	28	18	24	28	10	18
11	39	108	30	32	30	26	30	26	10	10
12	30	62	24	24	20	18	22	20	12	14
13	58	109	36	27	25	28	34	28	18	20
Av. men ..	38.3	86.6	29.3	33	42.2	22.1	.....	.....	.....	15.1
Av. wom. .	40.1	87.4	32.2	31.3	38.3	22.4	.....	.....	.....	15.5

(These averages taken from data of Professor Pyle.)

No. Pupil	Add. G.-S. I	Part-Whole	Add. P.-W. I	Ink Blot	Cancellation	Canc. Accur.	Word-Build.	Add. W.-B. I	Puzzle Box
Ave. ...	21.8	19.5	26.3	11.7	21.4	93	17.2	15.2	5-07
1	24	16	22	10	26	99	14	15	5-00
2	24	20	28	11	32	92	19	10	3-19
3	16	14	32	12	20	100	19	21	2-00
4	26	26	24	16	13	94	13	13	5-06
5	20	26	26	8	15	92	18	16	2-45
6	28	24	32	11	29	98	17	19	14-54
7	26	30	30	17	29	98	22	18	6-35
8	14	14	22	4	19	87	17	10	14-00
9	26	24	28	14	23	98	10	12	3-06
10	22	18	26	19	23	86	20	15	1-07
11	16	14	28	10	23	92	18	16	1-25
12	14	14	18	5	7	74	15	15	2-10
13	28	24	26	15	19	98	21	18	5-00
Av. men	.....	18.5	.....	10.6	22.2	.....	18.6	22.7	.....
Av.wom.	.....	19.7	.....	9.8	23.0	.....	21.1	22.0	.....

(These averages taken from data of Professor Pyle.)

Table I. exhibits the physical data for the 13 members of the class through the traits named, Table II. gives the psychological data, while Table III. gives the data for an experiment in the learning process and the transfer of training with the same class.

TABLE III

SHOWING DATA FOR INITIAL AND FINAL TESTS IN ADDITION AND DIVISION, WITH THE AVERAGES FOR THE CLASS. THE AMOUNT OF GAIN IS ALSO SHOWN

No. Pupil	Speed				Accuracy			
	Addition		Division		Addition		Division	
	Init. Test	Final Test	Init. Test	Final Test	Init. Test	Final Test	Init. Test	Final Test
1	53	71	108	137	81	91	96	98
2	30	47	91	89	89	100	99	95
3	32	41	65	91	84	87	96	97
4	37	48	97	126	82	90	98	99
5	25	24	44	78	83	72	100	100
6	42	61	82	88	92	95	97	98
7	45	62	122	127	98	100	100	100
8	20	27	32	49	76	93	99	100
9	39	43	114	115	88	93	95	95
10	38	44	77	92	90	88	95	99
11	31	41	51	66	94	95	96	97
12	21	26	45	56	43	54	75	93
13	70	88	90	115	100	96	100	100
Av.....	37.2	48.0	78.3	94.5	84.6	88.8	95.8	98.0
Gross gain.....	.....	10.8	.....	16.2	.....	4.2	.....	2.2
Per cent.....	.....	29.0	.....	22.0	.....	.....	.....	.....

Inasmuch as all the measurements and tests are described in detail in various publications, it is not deemed necessary to offer here more than a brief explanatory sentence concerning each.

Age—Recorded to the nearest birthday.

Sex—'F' represents female and "M" represents male.

Weight—Taken in the metric system and recorded to the nearest tenth of a kilogram.

Vital Capacity—Taken with a wet spirometer and recorded to the nearest hundred cubic centimeters.

Vital Index—Computed as the ratio between the vital capacity and the weight.

Height Standing—Taken in the metric system and recorded to the nearest centimeter.

Height Sitting—Taken and recorded the same as height standing.

Relation—The ratio of the sitting height to the standing height, recorded in terms of per cent.

Head Girth
Head Length } —All taken in the metric system and recorded to the nearest
Head Width one half centimeter.

Cephalic Index—The ratio of the width of the head to the length, expressed in terms of per cent.

Grip, Right Hand } —Taken in the English system and recorded to the
Grip, Left Hand } nearest pound.

Relation—The ratio of the grip of the left hand to that of the right, expressed in terms of per cent.

Strength, Pull—The number of pounds the subject can pull with both hands, the dynamometer being held near the chest, but not touching the body.

Logical Memory—The material used was "The Marble Statue."

Rote Memory—The material used was that given in Professor Pyle's manual. The score is the average for the concrete and the abstract lists of words taken together.

Digit-Symbol, Symbol-Digit, Free Association, Opposites, with the additional tests I, II and III, Genus-Species, with additional test I, Part-Whole, with additional test I, are all described in Pyle's manual.

These tests were all given according to the instructions given in the manual, the score recorded being the average for one minute.

Ink Blot—The material used was the set of 20 ink blots by Whipple. The score recorded being the number of suggestions written down in two minutes.

Cancellation—The material used was the standard test beginning with the letters h, p, l, g. The score recorded being the number of a's cancelled in one minute, with the per cent. of accuracy recorded in the next column.

Word-Building—The material used was composed of the letters a, e, o, b, m, t, with the letters e, a, i, r, l, p, for the additional test. The score recorded is the number of words made in 2½ minutes.

Puzzle Box—The Healy puzzle box was used in this test. None of the members of the class had ever seen the box. Each one was allowed two minutes to examine the box and was then given the button hook and directed to open the box as quickly as possible. The time recorded is the number of minutes and seconds required to perform the task.

In Table I. the averages at the top are for the entire class, men and women taken together.

In Table II., in addition to our own averages, the averages found by Professor Pyle for adults are also included at the bottom, insofar as these are comparable.

The slight discrepancy between the adult averages given by Pyle and those obtained from our class in the case of free association was noted by the class at the time and this test

was re-checked, but with no better results. It will be noted that the class showed no better ability upon the whole in writing words from free association than was shown in writing easy opposites. This fact may be explained upon the ground that in either case the test was not a test of ability to associate ideas so much as it was a test of ability to write down words, *i. e.*, a test in motor speed.

In the experiment in the learning process the materials used were the Thorndike addition sheets (single column addition examples of ten digits each, no zeros or ones included) and the division sheets of Thorndike, which were used by Kirby in his experiment with pupils in the Children's Aid Schools of New York.

These examples consist of columns of division problems arranged as follows: "48 equals . . . 5s and . . . remainder," the task being to fill in the blanks with the proper numbers, in this case the numbers being 9 and 3.

In the initial test 10 minutes were allowed for addition and 5 minutes for division, the score being the number of examples done correctly in the time given, which is called the speed. The score for accuracy represents the per cent. of the total number of examples done that was done correctly.

The final tests were given in the same way as the initial tests, but after an intervening daily practice of 5 minutes at addition for eight successive days, Sundays being omitted. There was no practice in the case of division.

Results of the Experiment

The class, composed of 4 men and 9 women, showing an average age of 29.2 years to the nearest birthday, showed an average initial ability of 37.2 columns added correctly in 10 minutes, with an average accuracy of 84.6 per cent.

As a result of 40 minutes of practice distributed over 8 days the class showed a gross gain in speed of 10.8 columns added correctly in 10 minutes, or a percentile gain of 29.0 per cent., with a gain of 4.2 per cent. in accuracy.

The average ability of the class in division in the initial test was 78.3 examples done correctly in 5 minutes, with an average accuracy of 95.8 per cent.

The final test, with no intervening practice in division, but with 40 minutes of practice in addition, showed a gross gain in speed of 16.2 examples done correctly in 5 minutes, or a percentile gain of 22.0 per cent., with a gain of 2.2 per cent. in accuracy.

Summary and Conclusions

1. Individual differences due to heredity are best illustrated in a study like this by such traits as height, weight and other traits not here recorded, as for example, color of hair, color of eyes, shape of features, complexion of skin, etc.

2. Individual differences due to sex are best shown by such traits as vital capacity, strength of grip, strength of pull, together with certain tests of motor capacity such as tapping, not here recorded.

3. Individual differences between persons of the same sex are often greater than the difference between groups of opposite sex. This appears in the case of imagination as tested with the ink blots, hard opposites, and the genus-species tests.

4. Individual differences due to school training are well illustrated by the addition and division tests, as it was evident that certain members of the class had mastered these combinations, while others evidently had not done so. In a general way it may be said that equal amounts of school training will produce somewhat the same results in a number of individuals, as for example, three years of school training will enable the majority of a class to read with the same general ability from, say the third reader, yet if the same class were tested with psychological tests it might be found that individual differences had been augmented by the three years of school training and experience.

5. Individual differences due to other causes are not so well shown in this particular class, since they were all of one race, one occupation, one nationality, and none was possessed with any defect of body or mind due to accident.

6. One of the most striking and perhaps the most significant examples of individual differences, from the standpoint of the teacher, was brought out in the puzzle box test.

The puzzle box designed and used by Dr. Healy in connection with his work at the Psychopathic Institute in Chicago, was the one used in this experiment. The origin, improvement, construction and use of this puzzle box are set forth in detail by the above author in an article appearing in Vol. XIII., No. 2 of the PSYCHOLOGICAL MONOGRAPHS.

The puzzle box is about six inches square by five inches deep. The lid is glazed and is hinged and fastened with a hasp, which in turn is held in place with a bolt hook and this is made fast with a ring attached to a string, and so on with a series of strings and rings fastened to metal pins within the box. By proper manipulation the fastenings may all be removed by means of a button hook and thus the box may be opened without the necessity of forcing at any point.

The following paragraph from the monograph of Dr. Healy will give a fair understanding of the operation of opening the box: "The color of the strings is, of course, arbitrary and is made different in order to facilitate the tracing the sequence of events necessary in opening the box. One removes first the ring over the post *K* and pulls out the staple from its holes in the back of the box, releasing the attached ring. Next the ring over the post *G* is lifted off, which loosens the short orange colored string so that the ring on the arm of post *D* can be readily removed. This then so loosens the blue string that the final ring can be pushed over the curved arm of the bolt hook and the latter may be withdrawn, the hasp lifted and the box opened."

With regard to the purpose and the significance of this test, Dr. Healy says: "The purpose of the test is obvious. It may bring out abilities or defects in the manipulative powers, in the ability to analyze a slightly complicated situation, in powers of attention and continuity of effort. . . . It is obvious that the general results obtained from this test must vary greatly, but there seem to be three main types of approach to the problem: first, random trials; second, intelligent profiting by the experiences of trials and successes or failures; third, conscious analysis of the puzzle as a whole with recognition of the relation of the

parts. Of course, on account of the differences in strength and manipulative power there would, other things being equal, be considerable difference in the times taken by the subjects. Indeed, altogether it has seemed to us that the method employed by the subject is of more significance than the time. Most of our twelve-year-old subjects have opened the box in from one and a half to nine minutes, but a certain number have finally failed."

While the above test was designed especially for use in the classification of juvenile delinquents, yet it seems evident that it tests the same abilities in any one who might undertake to open it. The individual differences brought out in our class of thirteen adults were vastly more significant than might be inferred from the examination of the data presented in the table accompanying this article, since we have here only recorded the time that was required for each person to open the box.

Observation of the efforts made by the different members of the class in trying to open the box showed that no one of the thirteen worked out the solution of the problem by the use of reason before attempting to open it. Most of them began by random trials. Two or three of them made definite moves which, as they thought, were correct, although most of these efforts were useless.

One significant fact was that most of the class failed to profit by mistakes made until the same mistake had been made over a number of times, in one case as high as seven times. The one step in the solution of the puzzle that caused most trouble was the removing of the staple at the back of the box after the first ring had been removed. In their own words, they "did not think that the staple would come out."

The experiment was carried a little further and each person was asked to retrace all the steps and thus lock up the box, after having succeeded in opening it. In almost every instance an effort was made to replace some of the rings or other fastenings *without first closing the lid!* Now no one but a child would fall into the error of locking a trunk, for ex-

ample, before closing the lid, and when this fact was called to their attention, then each one recoiled with chagrin that he had not been able to think of that himself.

One member even replaced the bolt hook and all the rings and fastenings complete and failed to notice that the hasp had not been placed over the staple! Subsequent experiments upon a number of adults at random have brought similar results in almost every instance.

7. Insofar as comparisons will admit between our data and that reported by Professor Pyle, there appears to be a very close correspondence, with the exception of the free association test.

An irregularity, however, in our data which could hardly be due to the small number of subjects, is that our subjects make a better showing in writing the additional tests in restricted association and invention than in the first tests given. The additional tests are supposed to be more difficult, hence one would naturally expect the record to be lower. Our explanation of this reversal of expectation is that the influence of practice in the first tests more than offsets the difference in the difficulty of the tests.

8. The outcome of this experiment tends to confirm the writer's contention that the experimental method of teaching psychology is the best method, even for short term courses. Of course it is understood that the regular textbook and reference reading, together with systematic notebook work were all carried on by the class.

9. In the experiment in the learning process and the transfer of training the improvement shown by the class was about the same as that reported by other investigators and corresponds very closely to unpublished results obtained by the writer from a group of 157 adults.

10. The apparent transfer of ability from the function of adding to that of dividing is partly explained by the fact that the division examples were arranged in a novel way which of course means a lower initial score and a higher score in the final test, due largely no doubt to the influence of the practice in the tests themselves.

On the other hand, a part of the gain in division may be accounted for by reference to improved habits of work brought about by the practice in addition, since none of the members of the class had been practicing with such material just in this way.